NUREG-1727

NMSS Decommissioning Standard Review Plan

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Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ABSTRACT

U.S. Nuclear Regulatory Commission (NRC) regulations require that a licensee must submit a decommissioning plan to support the decommissioning of its facility when it is required by license condition, or if the NRC has not approved the procedures and activities necessary to carry out the decommissioning and these procedures could increase the potential health and safety impacts to the workers or the public. In July 1998 the NRC directed the staff to develop a Standard Review Plan (SRP) that incorporates a risk-informed, iterative approach and provides clear guidance on complying with the As Low As is Reasonably Achievable provisions in the final License Termination Rule. This NUREG is the culmination of that staff effort and was presented to the Commission in July 2000, with staff indicating that it intended to commence using the SRP in September 2000. The goal of the SRP is to allow the NRC staff to evaluate information submitted by licensees in a timely, efficient, consistent manner and in such a way that the public health and safety is protected and the facility can be released in accordance with NRC's requirements. The SRP provides NRC staff with a description of the contents of specific decommissioning plan modules, as well as evaluation and acceptance criteria for use in reviewing decommissioning plans and other information submitted by licensees to demonstrate that the facility is suitable for release in accordance with NRC requirements.

NMSS DECOMMISSIONING STANDARD REVIEW PLAN

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Disclaimer

This Standard Review Plan (SRP) is being issued to describe and make available to the public methods acceptable to the NRC staff in implementing specific parts of the Commission's regulations, to delineate techniques and criteria used by the staff in evaluating decommissioning plans, and to provide guidance to licensees or responsible parties (as used throughout this SRP the term licensee or responsible party refers to the person(s) responsible for decommissioning the site). SRPs are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in this SRP will be acceptable, if they provide a basis for concluding that the decommissioning plan is in compliance with the Commission's regulations.

The information collections contained in this NUREG are covered by the requirements of 10 CFR Parts 20, 30, 40, 70, and 72, and were approved by the Office of Management and Budget, approval numbers 3150 - 0009, 0014, 0017, 0020, and 0132.

Public Protection Notification

If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

Acknowledgments

The Office of Nuclear Material Safety and Safeguards (NMSS) Decommissioning Standard Review Plan (SRP) is the result of a multi-year effort by U.S. Nuclear Regulatory Commission (NRC) staff at NRC headquarters and Regional offices. The SRP could not have been possible without the following individuals who contributed their time, talent, and efforts to develop this SRP:

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In addition to the individuals listed above, Matthew Borrick and John Collier of ICF Consulting contributed to the SRP, by developing the portions of the SRP dealing with financial assurance for decommissioning.

Finally, staff throughout NRC reviewed and provided valuable comments on the draft SRP modules prior to publishing it for public review and comment.

This Standard Review Plan (SRP) is being issued to describe and make available to the public methods acceptable to the NRC staff in implementing specific parts of the Commission's regulations, to delineate techniques and criteria used by the staff in evaluating decommissioning plans, and to provide guidance to licensees or responsible parties (as used throughout this SRP the term licensee or responsible party refers to the person(s) responsible for decommissioning the site). SRPs are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in this SRP will be acceptable, if they provide a basis for concluding that the decommissioning plan is in compliance with the Commission's regulations.

Background

On June 27, 1988, the U.S. Nuclear Regulatory Commission (NRC) amended its regulations at 10 CFR Parts 30, 40, 50, 70, and 72 to set forth the technical and financial criteria for decommissioning licensed nuclear facilities (53 FR 24018). These regulations were further amended on July 26, 1993, to establish additional recordkeeping requirements for decommissioning (58 FR 39628); on July 15, 1994, to establish timeframes and schedules for the decommissioning of licensed nuclear facilities (59 FR 36026); and on July 26, 1995, to clarify that financial assurance requirements must be in place during operations and updated when licensed operations cease. The NRC promulgated these amendments to ensure that the decommissioning of all licensed nuclear facilities is performed in a safe and timely manner, and that adequate funds are available to ensure that the decommissioning of licensed facilities can be accomplished.

On July 21, 1997, the NRC published the final rule on "Radiological Criteria for License Termination" (the License Termination Rule) as Subpart E to 10 CFR Part 20 (62 FR 39058). Subpart E establishes criteria for the release of sites for unrestricted use, if the residual radioactivity that is distinguishable from background results in a total effective dose equivalent to an average member of a critical group that does not exceed 0.25 milliSievert per year (mSv/yr) and the residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA). Subpart E also establishes criteria for license termination with restrictions on future land use, as long as specific conditions are met, and criteria for license termination in unusual situations where the site may exceed the 0.25 mSv/yr limit, but would be not be permitted to exceed 0.10 mSv/yr or 0.50 mSv/yr, under certain conditions.

Licensees and other individuals decommissioning licensed facilities are required to demonstrate to the NRC that the methods proposed by the licensee or responsible party will ensure that the decommissioning can be conducted safely and that the facility, at the completion of decommissioning activities, will comply with NRC's requirements for license termination. NRC regulations require that a licensee submit a decommissioning plan to support the decommissioning of its facility when it is required by license condition, or if the NRC has not approved the procedures and activities necessary to carry out the decommissioning and these procedures could increase the potential health and safety impacts to the workers or the public. The regulations also require that decommissioning plans contain: a description of the conditions of the site; the planned decommissioning activities; a description of the methods used to ensure protection of workers and the environment against radiation hazards during decommissioning; a description of the planned final radiation survey; an updated cost estimate; a comparison of the cost estimate with funds set aside for decommissioning; and, a plan for assuring the availability of adequate funds for the completion of decommissioning. The objective of the decommissioning plan is to describe the activities and procedures that the licensee intends to undertake to remove residual radioactive material at the facility to levels that meet NRC criteria for release of the site and termination of the radioactive materials license.

In March 1998, NRC staff completed development of Draft NUREG-1549, “Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.” NUREG-1549 was intended to provide an overall framework for dose assessment and decision-making at sites undergoing decommissioning. On July 8, 1998, the Commission directed the NRC staff to develop a Standard Review Plan (SRP) that incorporates the risk-informed, iterative approach in NUREG-1549, including providing clear guidance on complying with the ALARA provisions in the final License Termination Rule. In addition, the Commission directed the NRC staff to review the potential conservatism in the DandD Screen software, test the DandD code on a complex decommissioning site, and use it as the pilot for developing the SRP. The goal of the SRP is to allow the NRC staff to evaluate information submitted by licensees in a timely, efficient, consistent manner and in such a way that the public health and safety is protected and the facility can be released in accordance with NRC’s requirements. The SRP provides NRC staff with a description of the contents of specific decommissioning plan modules, as well as evaluation and acceptance criteria for use in reviewing decommissioning plans and other information submitted by licensees to demonstrate that the facility is suitable for release in accordance with NRC requirements.

In August 1998, NRC published Draft Regulatory Guide DG-4006 (DG-4006), “Demonstrating Compliance with the Radiological Criteria for License Termination,” for interim use and comment. It addressed the release from regulatory control of buildings and soil and described methodologies that could be used by licensees and others to comply with the License Termination Rule requirements in 10 CFR Part 20, Subpart E. In late 1999, NRC staff, in recognition that similar guidance was being presented in this SRP, decided to combine the guidance in DG-4006 with the guidance in this SRP and use the SRP as the primary guidance document. The staff will not publish a final version of the Regulatory Guide, although comments submitted by interested individuals on DG-4006 were considered as the staff finalized this SRP.

The guidance in this SRP for meeting the License Termination Rule supercedes the applicable portions of the following guidance except as incorporated herein[1]:

1. Regulatory Guide 3.65 “Standard Format and Content Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, and 70," June 1989;

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[1]Licensee are required to follow the superceded guidance to the extent incorporated into an approved decommissioning plan or license.

2. Regulatory Guide 3.66 “Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning Under 10 CFR Parts 30, 40, 70, and 72,“ June 1990;

3. Regulatory Guide 1.86 “Termination of Operating Licenses for Nuclear Reactors,” June 1974

4. Policy and Guidance Directive FC-90-2 “Standard Review Plan for Evaluating Compliance with Decommissioning Requirements for Source, Byproduct, and Special Nuclear Material License Applications,” April 1991;

5. Policy and Guidance Directive FC-91-2, “Standard Review Plan: Evaluating Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, 70,” August 1991;

6. Policy and Guidance Directive FC 83-23, “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source and Special Nuclear Material Licenses,” November 1983;

7. Policy and Guidance Directive PG-8-08, “Scenarios for Assessing Potential Doses Associated with Residual Radioactivity,” May 1994;

8. Policy and Guidance Directive FC-83-03 “ Standard Review Plan for Termination of Special Nuclear Material Licenses of Fuel Cycle Facilities,” March 1983

9. ”Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source and Special Nuclear Material,” August 1987;

10. ”Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source and Special Nuclear Material,” July 1982;

11. NUREG-1337 (Revision 1) the Review of Financial Assurance Mechanisms for Decommissioning Under 10 CFR Parts 30, 40, 70, and 72,” August 1989; and,

12. Draft Regulatory Guide DG-4006 “Demonstrating Compliance with the Radiological Criteria for License Termination” August 1998.

How to Use this SRP

As described above, on July 8, 1998, the Commission directed the NRC staff to develop an SRP that incorporates the risk-informed, iterative approach in NUREG-1549. In planning the development of this SRP, NRC staff determined that there were several approaches that could be employed to develop guidance for the review of decommissioning plans and other information to support the decommissioning of licensed facilities.

One approach could be to develop guidance on establishing broad decommissioning goals and describe, in a general way, the types of information about the decommissioning activities that the staff would need to evaluate the decommissioning plan. In the past, NRC staff guidance on the types of information that should be included in a decommissioning plan has followed this approach and, as such, the level of detail regarding the decommissioning activities included in decommissioning plans has varied significantly from site to site. In addition, NRC staff and licensee, or licensee's contractor, experience in decommissioning licensed facilities has varied, leading to different NRC staff project managers requesting different levels of detail in the descriptions of planned decommissioning activities. Typically, this has resulted in several iterations between the NRC staff and licensee because the licensee's understanding of the NRC staff's information requirements for decommissioning and the NRC staff's understanding of the licensee's plans and procedures have varied.

Another approach could be simply set general decommissioning goals, based on Part 20 public dose limits during decommissioning operations, and hypothetical doses to the appropriate critical population at the completion of decommissioning activities, and rely on in-process inspections to evaluate the effectiveness of the licensee's decommissioning activities. NRC staff is evaluating this approach at a limited number of sites, and the results of this pilot project may provide insights on future decommissioning guidance. However, for many licensees, an approach envisioned under the pilot program may not be appropriate, because of licensee capabilities and the complexity of the decommissioning project. As such, guidance would still be needed to plan, develop, and evaluate some decommissioning projects.

A third approach could be to develop specific SRPs for each category of licensee, describing the review procedures and information needs for each type of licensee. Although this approach would provide the NRC staff with clear guidance on the information needs and acceptance criteria applicable to any type of licensee, it would not incorporate the risk-informed, iterative approach envisioned by the Commission.

A fourth approach could be to use a "worst-case" approach, whereby the staff would determine the types of information that would be needed to perform a detailed evaluation of a decommissioning plan for a very complex decommissioning project, develop detailed descriptions of the types of information and acceptance criteria for this information, and then tailor the information to the specific decommissioning project.

NRC staff reviewed the numbers and types of licensees issued by the Commission and determined that the majority of licensees were those that used and possessed sealed sources, or relatively limited amounts of unsealed radioactive material. Because of the amounts, forms, and types of radioactive material used by these licensees, it did not appear that they would need to submit decommissioning plans or perform complex remedial activities to decommission their facilities in accordance with NRC's criteria.

However, some licensees would need to submit some information regarding either the status of their facilities when they requested license termination, or the activities that they intended to use to remediate their facility. The types of information that would be required could range from very simple descriptions of the radiological status of the facilities and the disposition of radioactive material possessed by the licensees to, in the case of licensees that proposed license termination under restricted conditions, very detailed descriptions of institutional controls, dose estimates to potential future critical groups, and arrangements to ensure that adequate financial assurance mechanisms were in place at license termination.

Based on the above, staff determined that the best approach would be to develop detailed descriptions of the types of information that could be required to evaluate proposed decommissioning activities and then tailor the information required by the licensees to the complexity and safety significance of the decommissioning project. As described below, this approach is implemented through several interactions between the NRC staff and licensees.

NOTE TO READERS

THE NRC STAFF IS REVISING NUREG/BR-0241 "NMSS HANDBOOK FOR DECOMMISSIONING FUEL CYCLE AND MATERIALS LICENSEES" TO IMPLEMENT THE APPROACH DESCRIBED BELOW. CURRENTLY, LICENSEES UNDERGOING DECOMMISSIONING ARE CLASSIFIED UNDER ONE OF FOUR "TYPES" BASED ON THEIR USE OF RADIOACTIVE MATERIAL DURING LICENSED OPERATIONS. NRC STAFF CURRENTLY EXPECTS TO REVISE THE HANDBOOK TO CLASSIFY LICENSEES UNDERGOING DECOMMISSIONING BY THE MANNER IN WHICH THEY WILL DECOMMISSION THEIR FACILITIES. THE "MINIMUM INFORMATION NEEDS" DESCRIBED BELOW WILL BE DEVELOPED AS PART OF THE REVISION TO NUREG/BR-0241.

To implement the approach chosen by the staff to incorporate the risk-informed, iterative approach the several staff took several actions. First, as described above, the staff developed very detailed SRP modules addressing the information needs, and acceptance criteria, that would be necessary to review a decommissioning plan for a very complex site. Next, the staff will revise the decommissioning "types" described in the NMSS Decommissioning Handbook (NUREG/BR-0241, "NMSS Handbook for Decommissioning Fuel Cyclye and Materials Facilities," March 1997) and established the minimum information that would be required under each of the decommissioning types. In the past the NRC staff classified facilities undergoing decommissioning by either the activities performed during the operation of the facilities or by the types of licensed material possessed by the licensee. However, in revising the Decommissioning Handbook to incorporate a risk-informed, iterative approach, the staff will base the classification of facilities undergoing decommissioning by the manner in which the licensee chose to conduct remedial activities. Staff should refer to Revision 1 of the NMSS Decommissioning Handbook for a description of the decommissioning types, to determine the minimum information that would be required to be submitted by licensees under each type and the required staff actions for each type of decommissioning.

When the NRC staff is informed that a licensee has decided to permanently cease licensed operations and decommission its facility, the staff should contact the licensee and determine if the licensee will need to submit a decommissioning plan to support its request for license termination. If the licensee does not need to submit a decommissioning plan, the NRC staff should follow the guidance in the NMSS Decommissioning Handbook for that decommissioning type. The approach for licensees that will need to submit a decommissioning plan is summarized below and the staff should refer to the NMSS Decommissioning Handbook for a detailed discussion of the specific NRC staff actions for each decommissioning type.

If the licensee will be required to submit a decommissioning plan, the Project Manager should schedule a meeting with the licensee to discuss the planned decommissioning and the approach that will be used to evaluate the information submitted to support the decommissioning. The staff and licensee should review the licensed operations, types and quantities of radioactive materials used at the facility, and any other activities (spills, leaks, etc.) that could affect decommissioning operations. The staff should also discuss the decommissioning goal envisioned by the licensee (i.e., license termination under unrestricted vs. restricted conditions) and the minimum information required as described in the NMSS Decommissioning Handbook, for that decommissioning goal. Using the SRP, the staff and the licensee should determine if any additional information will be required. Additional information may be required if decommissioning activities that will be undertaken by the licensee at the site could have an adverse impact on the public health and safety or the environment. The staff should then discuss the acceptance criteria for both the minimum information and any additional information as outlined in the SRP. Finally, the staff should prepare a site-specific checklist for evaluating the decommissioning plan. Appendix A provides a generic checklist, developed from the “Information to be Submitted” section of each SRP module, that may be used to develop this site-specific checklist. In this way, both the NRC staff and the licensee should, before the licensee begins to develop its decommissioning plan, have a good understanding of the types of information that should be included in the decommissioning plan, as well as the criteria that the NRC staff will use to evaluate the information submitted to support the decommissioning. This should help minimize the need for requests for additional information.

Note that much of the information that may be required to support the decommissioning of the facility may have been developed to support the original licensing of the facility. The intent of the decommissioning plan is not to require the licensee to regenerate this information, unless significant changes in the site warrant regenerating the information. Licensees should be allowed to use all previously developed information about the site as long as this information accurately depicts the current conditions of the site and environs.

Similarly, information requested in one section of the decommissioning plan need not be repeated in another section. Rather, licensees may reference the information in one section of the decommissioning plan in another section, as long as the information is adequate to support the information requirements of the second section.

A licensing review conducted using this SRP is not intended to be a detailed evaluation of all aspects of facility decommissioning. Specific information about implementation of decommissioning activities outlined in the licensee submital is obtained through the NRC review of procedures and operations done as part of the inspection function. In addition, staff should use the approach outlined in this SRP in a manner that allows for flexibility. The objectives of the review are to confirm that the decommissioning of the site will be accomplished consistent with applicable regulatory requirements. In conducting the evaluation, the staff should determine if the proposal submitted by the licensee is acceptable. In most cases, this involves assessing whether the methods and data used by the licensee in support of its proposal are acceptable, and if the results meet the requirements in 10 CFR Part 20, Subpart E.

Occasionally, the staff will need to conduct independent audit calculations. These calculations are usually limited to circumstances such as complex sites with new or unique proposals. Because of this, it is anticipated that independent modeling by the NRC staff will be on a limited basis. The results of these calculations are not the basis for the NRC staff acceptance of a submittal, but rather, serve as a confirmation of the conclusions reached by the staff as a results of its evaluation of the licensee’s proposal. In all reviews, the staff should be able to make a determination about the acceptability of a proposal based on its evaluation of the licensee’s proposal.

Streamlined Approach for Licensing Actions

If a licensee is required to submit a decommissioning plan to the NRC for review and approval, the staff will use this SRP to evaluate the information submitted by the licensee to support the decommissioning of its facility. The staff's review will include: (1) Acceptance Reviews; (2) Detailed Reviews; (3) Requests for Additional Information (RAIs); and (4) Safety and Environmental Report reviews. The staff shall ensure the application is complete during the acceptance review, and if it is not, return it to the licensee. If the application is complete, staff should then conduct its detailed review, and prepare its preliminary technical evaluation. Through this process, staff will be able to identify areas where questions need to be asked. This approach will help ensure that questions are limited to those areas where additional information is truly needed, and should help achieve only one round of questions (i.e., one RAI).

Acceptance Review

The staff will review the proposed decommissioning plan for completeness in accordance with this SRP. If the licensee's information is inadequate or incomplete, the staff should request that the licensee supply additional information. The staff may recommend that the decommissioning plan be: (1) rejected because of inadequate information; (2) placed on hold, pending submittal of requested information; or, (3) accepted for documentation. If the decommissioning plan is accepted for documentation, the detailed review of the decommissioning plan will begin. In performing the acceptance review the staff should use the information requirements summarized in the “Areas of Review” section of the SRP as a basis for reviewing the information in each SRP module. The staff should also use the checklist developed during the meeting with the licensee (see above) to aid in performing the acceptance review.

Detailed Qualitative and Quantitative Review

The staff will determine whether the licensee or responsible party has met the provisions in the individual SRP modules. The staff will verify that the licensee has included all the information described under the "Information to be Submitted" section of the SRP modules applicable to the site and that this information is sufficient to make the findings discussed in the "Evaluation Criteria" sections.

Requests for Additional Information

The staff should structure its reviews such that the number of RAIs is minimized, without diminishing the technical quality or completeness of the licensee's ultimate submittal. For example, the staff should first develop a set of additional information needs and clarifications and then meet with the licensee or responsible party to discuss the issues. This meeting would be noticed and conducted in accordance with NRC requirements and be documented in a meeting summary report. Any issues that could not be resolved during the meeting would be included in the formal RAI. In developing the final RAI, staff should document the insufficient or inadequate information submitted by the licensee and communicate what additional information is needed to address the identified deficiencies.

Safety and Environmental Report Reviews

These documents communicate the staff's position on the safety and environmental acceptability of the licensee's request, which forms the basis for the subsequent licensing action. The Safety Evaluation Report (or Technical Evaluation Report) should be used to document the evaluation findings, examples of which are included in each SRP module. Guidance concerning the conduct of environmental reviews is being developed separately.

Updating the SRP

NRC staff expects that, as the staff and licensees gain experience using this SRP to evaluate information to support the decommissioning of licensed facilities, procedures and criteria may need to be modified and areas for improvement will be identified. The first version or "Rev 0" of the SRP was published in September 2000. As part of the development of the SRP, NRC staff held a series of workshops in 1999 and 2000 to discuss the technical issues addressed in the SRP and to obtain input from the regulated community and industry and non-industry stakeholders on the approaches and procedures in the SRP. NRC staff also discussed publishing the first version of the SRP for use in 2000 and re-convening the workshop process after 2 years, to further refine and improve the SRP.

In addition, staff may, on its own initiative, revise or modify the criteria in the SRP based on issues that may be identified in the future. Licensees should contact the NRC staff to determine what, if any, changes have been made to the SRP since its initial publication, to ensure that they are using the most current version of the SRP.

Modifications to Decommissioning Programs and Procedures

As the radiological contamination at a facility is reduced, the potential doses to workers and the public from the residual radioactive material is also generally reduced. Therefore, in some cases, it may be appropriate to allow licensees to revise their decommissioning programs and procedures to address this reduced threat. If a licensee wishes to revise its program without prior NRC review and approval, the decommissioning program description needs to a detailed description of how the licensee will review and re-evaluate its program as conditions at the facility change and, as appropriate, modify its procedures to meet the reduced risk. If the staff is satisfied with the licensee's methodology for changes to its programs and procedures, the NRC may approve a decommissioning plan that allows revisions to programs and procedures without prior NRC approval, subject to the following conditions:

a. The change does not conflict with requirements specifically stated in the license or impair the licensee's or responsible party's ability to meet all applicable NRC regulations;

b. There is no degradation in safety or environmental commitments addressed in the NRC-approved decommissioning plan,

c. There are no significant adverse effects on the quality of the work, the remediation objectives or health and safety; and,

d. The change is consistent with the conclusions of actions analyzed in the Environmental Assessment, Environmental Impact Statement and Safety Evaluation Report developed for the decommissioning project;

e. Licensees may not change programs and procedures related to dose modeling, final radiological surveys or restricted use/alternative criteria without prior NRC approval.

The purpose of the staff's review of the licensee's procedures for modifying its decommissioning program is to evaluate the licensee's or responsible party's description of its methodology to modify its programs and procedures as decommissioning progresses with the removal of the residual radioactive material from the facility . In addition, the staff's review should determine if the licensee can demonstrate that it can adequately evaluate, revise, and monitor any future revisions in its programs so as to ensure that the level of protection afforded by the revisions are commensurate with the potential risk from residual radioactive material remaining at the site and with the provisions of 10 CFR Parts 19 and 20.

Because modifying decommissioning programs/procedures could be applicable to any of the following SRP sections, guidance on the minimum information that should be included in a decommissioning plan for these modification is included here in lieu of in each section. In some instances additional information may be required to support the modification of specific programs or procedures. NRC staff will need to work with licensees to identify this information and include it in the decommissioning plan for that licensee.

The following information should be included in the licensee's description of how modifications to decommissioning programs/procedures will be managed:

- A description of how the licensee will evaluate the radiological conditions, including surface and soil contamination, determine the potential doses to workers performing decommissioning activities and how the licensee will determine that the existing requirements are no longer necessary;

- A description of the method by which the licensee will use this information to develop the revised modifications to its program, and how the licensee will compare and evaluate any revised procedures with the radiological conditions at the site;

- A demonstration that the modification and approval review process is as rigorous as the review and approval process for Radiation Work Permits, includes approval from the same level of licensee management as revisions to the RWP, as well as review by all appropriate internal decommissioning organizations (including, but not limited to, the health and safety organization and the remediation organization). The review process will include an assessment relative to items a-e above,

- A description of how the various decommissioning organizations will monitor the implementation of the modifications to ensure that all personnel are following the revised procedures;

- A description of the immediate and long-term actions that will be taken in the event the revised procedures are found not to provide the same level of protection afforded by the existing procedures;
- A description of the periodic review of the procedures to ensure that the revisions are current and continue to be appropriate;

- A description of how the licensee will document each change to the procedures, and where it will be stored onsite, so it will be available for periodic review by NRC inspectors. This documentation should include: A description of each change, the technical justification for each change, when it became effective, how it was implemented, and who in management approved the change;
- A commitment to report all changes to NRC within 30 days of the change.

The staff will ensure that the licensee's proposed methodology:

- Evaluates the radiological conditions against the existing programs/procedures prior to developing the proposed programs/procedures;

- Develops the proposed modifications to the programs/procedures such that the level of protection is commensurate with the risk from the residual radioactive material at the facility;

- Obtains the appropriate level of review and approval within the individual decommissioning unit and overall decommissioning management organization, including an assessment of the change relative to items a-e, above;

- Monitors the implementation of the modifications to the programs/procedures;

- Includes provisions to respond to situations where the revised procedures are found to be inadequate;

- Periodically reviews the revised programs/procedures to ensure that the revisions are current and continue to be appropriate; and

- Properly documents the revisions to the programs/procedures and their implementation

- Includes a commitment to report the changes to NRC within 30 days of the change. This report must include a description of the changes, a summary of the safety and environmental evaluations performed for each change, and the revised decommissioning plan pages reflecting the changes.

A licensee may replace a Radiation Safety Officer (RSO) without prior approval from NRC, as long as: 1) the new RSO meets the criteria listed in Section 9.3.1 of this SRP; 2) the licensee or responsible party maintains the documentation that the individual meets the criteria listed in Section 9.3.1 of this SRP and made it available during inspections; and, 3) the licensee or responsible party informs NRC, in writing, within 30 days of the date of the change. The procedure for replacing the RSO should be included in the licensee's or responsible party's description of how modifications to decommissioning programs/procedures will be managed.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 1.0
EXECUTIVE SUMMARY

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the general information supplied by the licensee or responsible party to determine if the decommissioning objective and general decommissioning schedule comply with the U.S. Nuclear Regulatory Commission's (NRC's) requirements. This information should include: a) the name and address of the licensee or owner of the site; b) the location and address of the site; c) a brief description of the site and immediate environs; d) a summary of the licensed activities that occurred at the site, including the number and type of license(s); when the facility began and ceased using licensed material and the types and activities of licensed material authorized under the license(s); e) the nature and extent of contamination at the site; f) the decommissioning objective proposed by the licensee (i.e., restricted or unrestricted use); g) the derived concentration guidelines (DCGLs) proposed by the licensee or responsible party, the corresponding doses to these DCGLs and the method by which the DCGL was determined; h) if appropriate, the restrictions the licensee intends to use to limit doses as required in 10 CFR Part 20.1403 or 20.1404; and, i) a summary of the activities undertaken by the licensee to comply with 10 CFR Part 20.1403(d) or 20.1404(a)(4); the proposed initiation and completion dates of decommissioning; and any post-remediation, pre-license termination activities (such as groundwater monitoring); and a statement that the licensee is requesting that its license be amended to incorporate the decommissioning plan.

The purpose of the staff's review of the "Executive Summary" is to determine, in a general manner, whether the decommissioning plan submitted by the licensee or responsible party should provide an adequate demonstration that the licensee or responsible party understands, and has complied with, the requirements of 10 CFR 20.1400-1404, 30.36, 40.42, 70.38, and 72.54 for decommissioning and license termination. The staff will not perform a technical review of any information in the "Executive Summary."

REVIEW PROCEDURES

Acceptance Review

The staff will review the general information supplied by the licensee or responsible party for completeness in accordance with this Standard Review Plan (SRP).

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will verify that the specific information (licensee or responsible party's name and address etc.) is correct. The staff will make a qualitative assessment as to a) the licensee's or responsible party's compliance with the requirements of 10 CFR 20.1402, regarding the estimated dose to the public from residual radioactive material at the completion of decommissioning and the method that the estimated dose from residual radioactivity was determined; b) the requirements of 10 CFR 20.1403 or 20.1404, if the decommissioning alternative proposed by the licensee is license termination under restricted conditions or using alternate criteria, and; c) if the decommissioning schedule summarized by the licensee or responsible party is reasonable.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1400-1404, 30.36, 40.42, 70.38, 72.54

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should provide contributory evidence as to the licensee's or responsible party's understanding of the technical and institutional requirements for the decommissioning of licensed nuclear facilities. The staff's review should verify that the following information is included in the "Executive Summary":

- The name and address of the licensee or owner of the site;
- The location and address of the site;

- A brief description of the site and immediate environs;
- A summary of the licensed activities that occurred at the site, including the number and type of license(s); when the facility began and ceased using licensed material and the types and activities of licensed material authorized and used under the license(s);
- The nature and extent of contamination at the site;
- The decommissioning objective proposed by the licensee (i.e., restricted or unrestricted use);
- The DCGLs for the site, the corresponding doses from these DCGLs and the method that the DCGLs were determined;
- A summary of the ALARA evaluations performed to support the decommissioning;
- If the licensee or responsible party requests license termination under restricted conditions, the restrictions the licensee intends to use to limit doses as required in 10 CFR 20.1403 or 20.1404, and a summary of institutional controls and financial assurance arrangements for the site;
- If the licensee requests license termination under restricted conditions, or using alternate criteria, a summary of the public participation activities undertaken by the licensee to comply with 10 CFR 20.1403(d) or 20.1404(a)(4);
- The proposed initiation and completion dates of decommissioning;
- Any post-remediation activities (such as groundwater monitoring) that the licensee proposes to undertake prior to requesting license termination; and
- A statement that the licensee is requesting that its license be amended to incorporate the decommissioning plan.

EVALUATION FINDINGS

<u>Evaluation Criteria</u>

The staff should verify that the information summarized in "Information to be Submitted," above, is included in the Executive Summary. The staff's review should verify that the decommissioning alternative and activities proposed by the licensee are or will be in compliance with the requirements of 10 CFR 20.1402 or 20.1403 as appropriate and that the decommissioning timeframe appears to be reasonable.

<u>Sample Evaluation Findings</u>

None. The staff does not need to comment on the adequacy of the Executive Summary

SUGGESTED FORMAT

1. 1-2 paragraphs summarizing each of the items outlined in " Acceptance Criteria," above. Licensees are also encouraged to submit the information in electronic format.
2. Physical Specifications: See Appendix B

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 2.0
FACILITY OPERATING HISTORY

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the operating history of the facility is adequate to allow the staff to fully understand the types of radioactive material (and for Part 70 licenses, the hazardous chemicals produced from radioactive material) used at the site, the nature of the authorized use of radioactive materials at the site and the activities at the site that could have contributed to residual radioactive material being present at the site. This information should include the license number(s) and status of the license(s) held by the licensee or responsible party descriptions of: a) the activities authorized under the current license; b) past authorized activities using licensed radioactive material at the site; c) all previous decommissioning or remedial activities at the site; d) descriptions the locations of all spills and releases of radioactive material at the site; and, e) all previous burials of radioactive material, including those where the material was subsequently exhumed.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the facility operating history portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will verify that the specific information (license numbers, status and current authorized activities) is correct. In some instances the information described in the following sections may not be available, especially for older facilities. Lack of complete information on the past facility operations would not generally be sufficient justification for rejecting the decommissioning plan. Rather, the staff will make a qualitative assessment as to whether the licensee's or responsible party's descriptions of authorized activities, past operating activities, spills, and previous burials are adequate to serve as the basis for evaluating the accuracy of the descriptions of the radiological status of the facility and the decommissioning activities proposed by the licensee to remediate the facility can be conducted safely.

2.1 LICENSE NUMBER/STATUS/ AUTHORIZED ACTIVITIES

The purpose of the review of the description of the license number and authorized activities is to verify that the number and types of licenses and the status of each license are accurate and to familiarize the staff with the licensee's use of radioactive material at the site. This will allow the staff to evaluate the licensee's determination of the radiological status of the facility and the licensee's planned decommissioning activities, to ensure that the decommissioning can be conducted in accordance with U.S. Nuclear Regulatory Commission (NRC) requirements.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to enable the staff to fully understand what licensed activities are currently being performed by the licensee. The staff's review should verify that the following information is included in the "Authorized Activities" section of the facility decommissioning plan:

- The radionuclides and maximum activities and quantities of radionuclides authorized and used under the current license;
- The chemical forms of the radionuclides authorized and used under the current license;
- A detailed description of how the radionuclides are currently being used at the site;
- The location(s) of use and storage of the various radionuclides authorized under current licenses;
- A scale drawing or map of the building or site and environs showing the current locations of radionuclide use at the site; and
- A list of amendments to the license since the last license renewal.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the number and type of license(s) and the status of each license are accurate by comparing the information presented in the decommissioning plan with current NRC license information. The staff should verify that the information summarized under "Information to be Submitted", above is included in the licensee's description of the authorized activities under the license. The staff should verify that this information is correct by comparing it with current NRC license information.

Sample Evaluation Findings

The NRC staff has reviewed the information in the "Facility Operating History" section of the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 2 ("Facility Operating History"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to aid the NRC staff in evaluating the licensee's determination of the radiological status of the facility and the licensee's planned decommissioning activities, to ensure that the decommissioning can be conducted in accordance with NRC requirements. **(Note to reviewers - this finding incorporates the results of the staff's assessment under Sections 2.2, 2.3, 2.4, and 2.5, below)**

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullets 1 and 2 in Acceptance Criteria, above should be no more than a few sentences. Up to 4 pages summarizing each of the remaining items outlined in “Acceptance Criteria,” above. Licensees are also encouraged to submit the information in electronic format.

2.2 LICENSE HISTORY

The purpose of the review of the description of the license history is to familiarize the staff with the licensee’s previous uses of radioactive material at the site so that the staff can evaluate whether the licensee’s determination of the radiological status of the facility is adequate and the licensee’s planned decommissioning activities are appropriate to ensure that the decommissioning can be conducted in accordance with NRC requirements.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.35(g), 40.36(f), 70.25(g), 72.30(d)
- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to enable the staff to fully understand what licensed activities were performed by the licensee in the past.
The staff’s review should verify that the following information is included in the license history section of the facility decommissioning plan:

- The radionuclides and maximum activities of radionuclides authorized and used under all previous licenses;

- The chemical forms of the radionuclides authorized and used under all previous licenses;

- A detailed description of how the radionuclides were used at the site;
- The location(s) of use and storage of the various radionuclides authorized under all previous licenses as described in 10 CFR 30.35(g), 40.36(f), 70.25(g), 72.30(d); and

- A scale drawing or map of the site, facilities and environs showing previous locations of radionuclide use at the site as described in 10 CFR 30.35(g), 40.36(f), 70.25(g), 72.30(d).

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of the license history under the license. The staff should verify that this information is correct by comparing it to historical NRC license information.

Sample Evaluation Findings

None. The staff should combine the assessment of this section of the decommissioning plan with Section 2.1 above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five pages summarizing each of the items outlined in "Acceptance Criteria," above. Licensees should be encouraged to submit the information in electronic format.

2.3 PREVIOUS DECOMMISSIONING ACTIVITIES

The purpose of the review of the license's previous decommissioning activities is to provide the staff with information that will aid the staff in evaluating the licensee's determination of the radiological status of the facility and whether previous decommissioning activities are sufficient to comply with current NRC criteria for license termination.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.35(g), 40.36(f), 70.25(g), 72.30(d)
- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to enable the staff to fully understand what decommissioning activities were performed by the licensee in the past. The staff's review should verify that the following information is included in the previous decommissioning activities section of the facility decommissioning plan:

- A list or summary of areas at the site that were remediated in the past;
- A summary of the types, forms, activities and concentrations of radionuclides that were present in previously remediated areas;
- The activities that caused the areas to become contaminated;
- The procedures used to remediate the areas and the disposition of radioactive material generated during the remediation;
- A summary of the results of the final radiological evaluation of the previously remediated area including the locations and average radionuclide concentrations in the previously remediated areas, and
- A scale drawing or map of the site, facilities and environs showing the locations of previous remedial activity.

EVALUATION FINDINGS

<u>Evaluation Criteria</u>

The staff should verify that the information summarized under "Information to be Submitted", above, is included in the licensee's description of the previous decommissioning activities carried out under the license. The staff should verify, to the extent practicable, that this information is correct by comparing it with any historical NRC license information.

<u>Sample Evaluation Findings</u>

None. The staff should combine its assessment of this section of the decommissioning plan with Section 2.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Information requested for bullets 1,2 and 5 in "Acceptance Criteria," above, may be presented in tabular form. Three to five paragraphs summarizing each of the remaining items outlined in "Acceptance Criteria," above. Licensees are also encouraged to submit the information in electronic format.

2.4 SPILLS

The purpose of the review of the license's description of spills that have occurred at the site is to provide the staff with information that will aid in the staff's evaluation of the licensee's determination of the radiological status of the facility. In this context a “spill” is defined as an uncontrolled release of radioactive material at the site that results in radioactive material being present in the site environs or any unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. Note that controlled releases, such as liquid effluents released to surface water bodies in accordance with 10 CFR 20 Appendix B, would not be considered a “spill”. However, the point of release may need to be evaluated to determine the radiological status of the point of release as well as the radiological status of surrounding environs.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.35(g)(1), 40.36(f)(1), 70.25(g)(1),72.30(d)(1)
- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to enable the staff to determine whether spills that have occurred at the facility in the past could impact on the current radiological status of the facility. The staff’s review should verify that the following information is included in the spills section of the decommissioning plan (note that this information may be presented with the information discussed in Section 2.3, “Previous Decommissioning Activities,” above):

- A summary of areas at the site where spills (or uncontrolled releases) of radioactive material occurred in the past;

- The types, forms, activities and concentrations of radionuclides involved in the spill or uncontrolled release, and

- A scale drawing or map of the site, facilities, and environs, showing the locations of spills.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted”, above is included in the licensee’s description of spills that have occurred at the facility. The staff should verify that this information is correct by comparing it to any historical NRC license information.

Sample Evaluation Findings

None. The staff should combine their assessment of this section of the decommissioning plan with Section 2.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees should be encouraged to submit the information in electronic format.

2.5 PRIOR ON-SITE BURIALS

The purpose of the review of the license’s description of prior on-site burials is to provide the staff with information that will aid in the staff’s evaluation of the licensee’s determination of the radiological status of the facility.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.2002, 30.35(g)(3)(iii), 40.36(f)(3)(iii), 70.25(g)(3)(iii),
- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

- NUREG 1101, Volume 1"On-site Disposal of Radioactive Waste” March 1986

Information to be Submitted

The information supplied by the licensee should be sufficient to enable the staff to determine whether previous burials at the facility could impact on the current radiological status of the facility. Note that all radioactive material at the site would be included in the staff’s evaluation of the doses from residual radioactive material and as such would be included in any dose assessments that are performed for the facility. The staff’s review should verify that the following information is included in the previous burials section of the decommissioning plan:

- A summary of areas at the site where radioactive material has been buried in the past;

- The types, forms, activities and concentrations of waste and radionuclides in the former burial(s); and

- A scale drawing or map of the site, facilities and environs showing the locations of former burials.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of former burials at the site. The staff should verify that this information is correct by comparing it to historical NRC license information, as well, as information submitted pursuant to 10 CFR 20.302, 20.304, 20.2002, 30.35(g)(3)(iii), 40.36(f)(3)(iii), 70.25(g)(3)(iii) and NUREG 1101, Volume 1. Note that the information required pursuant to 30.35(g)(3)(iii), 40.36(f)(3)(iii), and 70.25(g)(3)(iii) may not be submitted to NRC until license termination. However, the licensee should include or use a summary of this information in developing this section of the decommissioning plan.

Sample Evaluation Findings

None. The staff should combine their assessment of this section of the decommissioning plan with Section 2.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in "Acceptance Criteria," above. Licensees should be encouraged to submit the information in electronic format.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 3.0
FACILITY DESCRIPTION

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	Division of Waste Management - High Level Waste and Performance Assessment Branch	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the facility and environs is adequate to allow the staff to: (1) evaluate the licensee's estimation of doses to on- and off-site populations during, and at the completion of decommissioning; and, (2) evaluate the licensee's estimation of the impacts of the proposed decommissioning alternative on the site and surrounding areas. This information should include a description of the site and environs; a description of the current population distribution, including minority populations; a summary of current and potential future uses of land in and around the site; descriptions of the site meteorology, geology, seismology, climatology, surface and groundwater hydrology; descriptions of the natural and water resources at the site; a description of the ecology of the site; and, a summary of all endangered species at the site.

THIS SECTION OF THE SRP WAS DEVELOPED TO PROVIDE GUIDANCE ON THE TYPES OF INFORMATION THAT WOULD BE REQUIRED FOR THE MOST COMPLEX TYPES OF SITES. THESE SITES COULD, BUT NOT NECESSARILY, INCLUDE SITES REQUIRING COMPLEX SITE-SPECIFIC DOSE MODELING, THOSE THAT WOULD CONTAIN RESIDUAL CONTAMINATION AT DEPTHS EXCEEDING 15-30 CM, AND/OR THOSE HAVING ONSITE DISPOSAL CELLS FOR RADIOLOGICALLY CONTAMINATED DECOMMISSIONING

WASTE. LESS COMPLEX SITES WOULD NOT NEED TO INCLUDE ALL OF THE INFORMATION DESCRIBED BELOW IN THEIR DECOMMISSIONING PLANS. FOR SOME COMPLEX SITES, LICENSEES MAY PROVIDE THIS INFORMATION IN THE DECOMMISSIONING PLAN OR ENVIRONMENTAL REPORT. AS DISCUSSED IN THE "HOW TO USE" SECTION OF THIS SRP, THE NRC STAFF AND THE LICENSEE SHOULD WORK TOGETHER TO ESTABLISH THE AMOUNT AND TYPE OF INFORMATION NEEDED TO SUPPORT THE DECOMMISSIONING PLAN FOR EACH INDIVIDUAL FACILITY AND THE BEST METHOD TO PROVIDE THE NRC WITH THE INFORMATION.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the facility description portion of the decommissioning plan information without assessing the technical accuracy or completeness of the information. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is generally informational in nature however, significant detailed technical analysis may be required. The staff will verify that the specific information concerning site meteorology, geology, seismology, climatology, surface and groundwater hydrology, geotechnical characteristics, natural and water resources, ecology, and endangered species at the site is complete and accurate. The staff will make a qualitative assessment as to whether the licensee's or responsible party's descriptions of the site and environs and summary of current and potential future land uses are adequate to serve as the bases for evaluating the licensee's or responsible party's dose and environmental impacts estimates.

3.1 SITE LOCATION AND DESCRIPTION

The purpose of the review of the description of the site location and description is to verify that sufficient information is presented to allow the NRC staff to understand the physical characteristics of the site and relationship of the site to surrounding areas. This will aid the staff in evaluating the licensee's or responsible party's dose and environmental impacts estimates and planned decommissioning activities to ensure that the decommissioning can be conducted in accordance with NRC requirements.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the physical characteristics of the site. The staff's review should verify that the following information is included in the description of the site description and location section of the decommissioning plan:

- The size of the site in acres or square meters;
- The State and county in which the site is located;
- The names and distances to nearby communities, towns and cities;
- A description of the contours and natural features of the site;
- The elevation of the site;
- A description of the man-made features of the site, such as buildings, roads, settling ponds, etc.;
- A description of property surrounding the site, including the location of all off-site wells used by nearby communities or individuals;
- The location of the site relative to prominent features such as rivers and lakes. To facilitate presentation of this information, U.S. Geological Survey (USGS) topographic maps may be provided;
- A map that shows the detailed topography of the site using a contour interval (such as 2 feet or 1 meter) and including plot plans, the locations of characterization borings and monitoring wells, and the positions and types of geologic characterization activities;
- The location of the nearest residences and all significant facilities or activities near the site; and
- A description of the facilities (buildings, parking lots, fixed equipment, etc.) at the site.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted”, above, is included in the licensee’s description of the site and environs. The staff’s review should verify, to the maximum extent practicable, that the information supplied by the licensee or responsible party is accurate by comparing it with licensing and inspection information maintained in NRC files.

Sample Evaluation Findings

None. The staff does not need to comment on the accuracy of the information presented in the site description/ location section of the decommissioning plan

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

3.2 POPULATION DISTRIBUTION

The purpose of the review of the description of the population distribution is to determine if the licensee or responsible party has supplied sufficient information on the makeup and distribution of the population in the vicinity of the site to allow the NRC staff to evaluate the licensee’s or responsible party’s estimate of doses to off-site individuals during and at the completion of decommissioning, and to determine if population characteristics warrant an evaluation of environmental justice issues.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

- NMSS Policy and Procedures Letter 1-50 "Environmental Justice in NEPA Documents”

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine the population makeup and distribution in the vicinity of the site. The staff’s review should verify that a summary of current and projected populations in the vicinity of the site, by principal compass sectors, is included in the decommissioning plan. This summary should be sufficiently detailed to allow the determination of doses to off-site individuals via atmospheric pathways. In addition, the staff will verify that the makeup and distribution of minority and low-income populations are sufficiently described in the decommissioning plan as to allow the environmental justice evaluation described in Policy and Procedures Letter 1-50. The decommissioning plan should include the following:

- A summary of the current population in and around the site, by compass vectors;
- A summary of the projected population in and around the site by compass vectors;
- A list of minority populations by compass vectors; and
- Demographic data by census block group to identify minority or low-income populations.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s or responsible party’s description of the distribution of populations around the site. The staff will verify the licensee’s or responsible party’s population data against available independent population data (e.g., information from the Census Bureau including any special census that may have been conducted, local and State agencies, and regional Councils of Government). The staff will evaluate project population information by comparing it to projections made by local planning boards or offices.

Sample Evaluation Findings

None. The staff should combine the assessment of this section of the decommissioning plan with Section 3.1 above, and 3.3, below (see Sample evaluation Findings at Section 3.3, below).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees should be encouraged to submit the information in electronic format.

3.3 CURRENT/FUTURE LAND USE

The purpose of the description of current and future land use is to provide the staff with information that will aid the staff in evaluating the licensee’s estimates of doses to on and off-site individuals during and at the completion of decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to understand what current land uses are, and what local, regional, or State planning boards or office anticipate the future land uses will be at the site. The staff's review should verify that the licensee or responsible party has used all available data on land use, plans and trends in land use, land use controls (such as zoning), potential for growth, or other factors likely to inhibit or stimulate growth in the area by comparing it with publically available information from local, regional or State land use planning boards or offices. The decommissioning plan should include a description of the current land uses in and around the site and a summary of anticipated land uses.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's discussion of current and future land use. The staff should verify, to the extent practicable, that this information is correct by comparing it to publically available information on current land use in the vicinity of the site, land use trends in and around the site and expected future uses of the land in and around the site.

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

3.4 METEOROLOGY AND CLIMATOLOGY

The purpose of the review of the license's description of meteorology and climatology is to determine if the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee's or responsible party's estimations of doses to on- and off-site individuals during and at the completion of decommissioning operations.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

- RegGuide 1.23 "Onsite Meteorological Programs" (Safety Guide 23)

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine how local weather patterns will affect the estimation of doses to on- and off-site individuals during and at the completion of decommissioning operations. The staff's review should verify that the following information is included in the climatology and meteorology section of the decommissioning plan:

- A description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general air-flow patterns (wind direction and speed), temperature and humidity, precipitation, and relationships between synoptic-scale atmospheric processes and local meteorological conditions;
- Seasonal and annual frequencies of severe weather phenomena including tornados; water spouts, thunderstorms, lightning, hail, and high air pollution potential;
- Weather-related radionuclide transmission parameters including average and extreme wind vectors and average and extreme duration and intensity of precipitation events;
- Routine weather-related site deterioration parameters including precipitation intensity and duration, wind vectors, and temperature and pressure gradients;
- Extreme weather-related site deterioration parameters including tornados, water spouts, thunderstorms, hail, and extreme air pollution (from offsite sources); and,
- A description of the local (site) meteorology in temperature, atmospheric water vapor, precipitation, fog, atmospheric stability and air quality; and
- The National Ambient Air Quality Standards Category of the area in which the facility is located and, if the facility is not in a Category 1 zone, the closest and first downwind Category 1 Zone.

EVALUATION FINDINGS

Evaluation Criteria

The staff will review the licensee’s or responsible party’s description of the site climatology and meteorology for completeness and adequacy of basic data. The wind and atmospheric stability data should be based on onsite data. The other summaries should be based on nearby representative stations with long record retention periods. When off-site data are used, the staff will determine how well the data represent site conditions and whether more representative data are available. The staff will use National Oceanic and Atmospheric Administration (NOAA) (U.S. Department of Commerce) State meteorological summaries ("State Climatological Summary"), local climatological data ("Local Climatological Data Annual Summary with Comparative Data"), and NOAA Environmental Data Service summaries pertinent to the site to evaluate the representativeness of stations and periods of record. The staff should be familiar with all primary meteorological data collection locations. The staff will ensure that all topographic maps and topographic cross-sections presented by the licensee are legible and well-labeled so that the information needed during the review can be readily extracted. Points of interest such as facility structures, site boundary, and buffer zone should be marked on all maps and diagrams.

The staff will compare the licensee's assessment of the effect of topography with standard assessments such as those presented in "Meteorology and Atomic Energy - 1968" (Slade, 1968) and decide whether the standard regulatory atmospheric diffusion models are appropriate for this site. The staff will review for completeness and authenticity the general climatic description of the region in which the site is located. Climatic parameters such as air masses, general air flow, pressure patterns, frontal systems, and temperature and humidity conditions reported by the licensee will be checked against standard references (Thorn, 1968; U.S. Department of Commerce, 1968) for appropriateness with respect to location and period of record. The staff will verify the licensee's description of the role of synoptic-scale atmospheric processes on local (site) meteorological conditions against the descriptions provided in "Climatic Atlas of the United States" and "Local Climatological Data - Annual Summary With Comparative Data" (both published by the U.S. Department of Commerce).

Because meteorological averages and extremes can only be obtained from stations in the region of the site that have long record retention periods, and the stations are not usually very close to the site, the staff will first determine the representativeness of the data to site conditions and then ascertain the adequacy of the stations and their data. The staff will verify: (1) recorded meteorological averages and extremes using standard publications such as “Storm Data”, published by the U.S. Department of Commerce; (2) other averages and extremes using “State Climatological Summaries” and “Storm Data”, published by the U.S. Department of Commerce; (3) the potential for high air pollution; (4) extreme winds and their distribution using RegGuide 1.234 and “Meteorology and Atomic Energy - 1968" (Slade, 1968); and, (5) gust factors using RegGuide 1.23

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees are also encouraged to submit the information in electronic format.

3.5 GEOLOGY AND SEISMOLOGY

The purpose of the review of the licensee’s or responsible party’s description of the site geology and seismology is to determine if the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee’s or responsible party’s estimations of doses to on- and off-site individuals during and at the completion of decommissioning operations.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine how site geological and seismological characteristics will effect the estimation of doses to on and off-site individuals during and at the completion of decommissioning operations. The staff’s review should verify that the geology and seismology section of the decommissioning plan contains the following information:

Geology

- A detailed description of the geologic characteristics of the site and the region around the site;

- A discussion of the tectonic history of the region, regional geomorphology, physiography, stratigraphy, and geochronology. All tectonic structures should be identified, in particular folds and faults in the region around the site, and their geologic and structural history should be discussed. The relationship between seismicity and tectonic structures and the earthquake-generating potential of any active structures should be determined;

- A regional tectonic map showing the site location and its proximity to tectonic structures should be provided. Appropriate references of supporting documents should be provided with regional physiographic and topographic maps, geologic and structure maps, fault maps, stratigraphic sections, boring logs, and aerial photographs;

- A description of the structural geology of the region and its relationship to the site geologic structure should be discussed. Any faults, folds, open jointing, fractures, and shear zones in the region must be identified, and their significance to the facility should be discussed;

- A description of any crustal tilting, subsidence, karst terrain, landsliding, and erosion;

- A description of the surface and subsurface geologic characteristics of the site and its vicinity. The description should include local stratigraphic units and their accepted names, ages, genetic relationships, and lithologies. To facilitate the presentation, these descriptions should be accompanied by appropriately scaled geologic maps; Descriptions of mineralogy, particle size, organic materials, degree of cementation, zones of alteration, and depositional environment of unconsolidated strata should be included;

- A description of the geomorphology of the site, including USGS topographic maps that emphasize local geomorphic features pertinent to the site. A description of the geomorphic processes affecting the present-day topography of the disposal site and vicinity should be included. Information should include descriptions of processes such as mass wasting, erosion, slumping, landsliding, and weathering where appropriate. The discussion of relevant geomorphic processes should include their rates, frequencies of occurrence, and controlling mechanisms or factors;

- A description of the location, attitude, and geometry of all known or inferred faults in the site and vicinity. Fault displacements should be identified and potential recurrence intervals addressed;

- A discussion of the nature and rates of deformation such as folding within the site and relate these to the local stress regime. Any joint sets within the site, including their densities and orientations, should be described, and their relative ages discussed. Remineralization and mineralization history of the various joint sets should also be discussed. Solution cavities and crevices in the bedrock should be described and discussed, if applicable; and

- A description of any man-made geologic features such as mines or quarries.

<u>Seismology</u>

- A description of the seismicity, tectonic characteristics of the site and region, correlation of earthquake activity with geologic structures and tectonic provinces, maximum earthquake potential, seismic wave transmission characteristics of the site, design earthquake, settlement and liquefaction, and geophysical methods for site characterization; and

- A complete list of all historical earthquakes that have a magnitude of III or more or a modified Mercalli intensity of IV or more within 320 kilometers (200 miles) of the site. The listing should include all available information about the earthquakes such as epicenter coordinates, depth of focus, origin time, intensity, and magnitude, augmented by a map showing the locations of these earthquakes. The references from which the information was obtained should be indicated. In addition, any earthquake that induced geologic hazard (e.g., landsliding or liquefaction) should be identified, and the acceleration that caused the hazard should be provided.

EVALUATION FINDINGS

Evaluation Criteria

The staff will review for completeness the information on geologic site characterization in the decommissioning plan. If the information reflects the results of a thorough literature search and an adequate reconnaissance and physical examination of the regional and site conditions by the licensee or responsible party the decommissioning plan will be considered acceptable. Consultations with commercial companies and Federal, State, and local government agencies that may have had occasion to characterize the site will help ensure the adequacy of the characterization in the decommissioning plan. The review can be completed quickly if the decommissioning plan contains sufficient information to allow the staff to make an independent assessment of the licensee's or responsible party's assumptions, analyses, and conclusions. The staff will thoroughly review the information in the decommissioning plan to determine if all interpretations and conclusions are founded on sound geologic practice and do not exceed the limits of validity of the data in the decommissioning plan or of other data published in the literature.

Sample Evaluation Findings

None.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in "Acceptance Criteria," above. Licensees are also encouraged to submit the information in electronic format.

3.6 SURFACE WATER HYDROLOGY

ACCEPTANCE CRITERIA

The purpose of the review of the license's description of the surface water hydrology at the site is to determine if the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee's or responsible party's estimations of doses to on- and off-site individuals during and at the completion of decommissioning operations.

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Evaluation Criteria

The information supplied by the licensee should be sufficient to enable the staff to determine whether surface water characteristics could impact on the doses to on or off-site individuals during or at the completion of decommissioning. The staff's review should verify that the following information is included in the surface water hydrology section of the decommissioning plan:

- A description of site drainage and surrounding watershed fluvial features, including important water users;
- Water resource data, including maps, hydrographs, and stream records from other agencies (e.g., U.S. Geological Survey and U.S. Army Corps of Engineers);
- Topographic maps of the site that show natural drainages and man-made features
- A description of the surface water bodies at the site and surrounding areas, including the location, size, shape, and other hydrologic characteristics of all streams, lakes, or coastal areas;
- A description of existing and proposed water control structures and diversions (both upstream and downstream that may influence the site);
- Flow-duration data that indicate minimum, maximum, and average historical observations for surface water bodies in the site areas;
- Aerial photography and maps of the site and adjacent drainage areas identifying features such as drainage areas, surface gradients, and areas of flooding;

- An inventory of all existing and planned surface water users, whose intakes could be adversely affected by migration of radionuclides from the site . The inventory should include the owner, location, type, and amount of use; source of supply; type of intake; and surface water quality data;

- Topographic and/or aerial photographs that delineate the 100-year floodplain at the site; and

- A description of any man-made changes to the surface water hydrologic system that may influence the potential for flooding at the site. (Such changes may include construction of reservoirs, urban development, strip mining, lumbering, etc.). The description of these changes should include the proximity of the affected area to the site, the surface water bodies affected, the size of the area affected, and the potential effects at the site.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of the surface water features at the site. Acceptance of the information in the decommissioning plan will be based in part on a qualitative evaluation of the completeness and adequacy of the information and of maps. Descriptions and evaluations of structures, facilities, etc., are adequate if they are sufficiently complete to allow independent evaluations of the effects of flooding and intense rainfall. Site topographic maps are acceptable if they are of good quality, are legible, and adequate in coverage to substantiate applicable data and analyses. The descriptions of the hydrologic characteristics of surface water features and water use are acceptable if they are detailed and generally correspond to those of the USGS, National Oceanographic and Atmospheric Administration, Soil Conservation Service, Corps of Engineers, or appropriate State and river basin agencies. Descriptions of existing or proposed reservoirs and dams that could influence conditions at the site should be based on reports of the USGS, U.S. Bureau of Reclamation, Corps of Engineers, and others; these reports normally include tabulations of drainage areas, types of structures, appurtenances, ownership, seismic and spillway design criteria, elevation-storage relationships, and short- and long-term storage allocations.

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees are also encouraged to submit the information in electronic format.

3.7 GROUNDWATER HYDROLOGY

The purpose of the review of the license's description of the groundwater hydrology section of the decommissioning plan is to determine if the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee's or responsible party's estimations of doses to on- and off-site individuals during and at the completion of decommissioning operations.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine how the groundwater characteristics of the site effect the doses to on or off-site individuals during or at the completion of decommissioning. The staff's review should verify that the following information is included in the groundwater hydrology section of the decommissioning plan:

- A description of the saturated zone including all potentially affected aquifers, the lateral extent, thickness, water-transmitting properties, recharge and discharge zones, groundwater flow directions and velocities, and other information that can be used to create an adequate conceptual model of the saturated zone;

- Descriptions for monitor wells, including location, elevation, screened intervals, depths, construction and completion details, and hydrogeologic units monitored. The description should include domestic, industrial and/or municipal wells or other monitoring devices, if applicable, and any construction and completion details for these devices, when available. Descriptions of all aquifer tests should also be provided, including test data and a discussion of the assumptions, analysis, and test procedures used;

- Physical parameters such as storage coefficients, transmissivities, hydraulic conductivities, porosities, and intrinsic permeabilities should be included.

- A description, to the extent practicable, of groundwater flow directions and velocities (horizontal and vertical) for each potentially affected aquifer. When applicable, the groundwater hydrology should be described by making use of hydrogeologic columns, cross-sections, and water table and/or potentiometric maps;

- A description of the unsaturated zone including descriptions of the lateral extent and thickness of permeable and impermeable zones, potential conduits of anomalously high flux, and direction and velocity of unsaturated flow;

- Information on all monitor stations including location and depth

- A description of physical parameters including the spatial and stratigraphic distribution of the total and effective porosity; water content variations with time; saturated hydraulic conductivity; characteristic relationships between water content, pressure head, and hydraulic conductivity; and hysteretic behavior during wetting and drying cycles, especially during extreme conditions;

- A description of the numerical analyses techniques used to characterize the unsaturated and saturated zones including the model type, justification, documentation, verification, calibration and other associated information. In addition, the description should include the input data, data generation or reduction techniques, and any modifications to these data; and

- The distribution coefficients of the radionuclides of interest at the site.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s or responsible party’s description of the groundwater hydrology at the site. The staff will review the information on the saturated zone by evaluating the testing and monitoring program and sample collection procedure. The staff will evaluate the rationale for choosing particular sampling locations and verify that they are commensurate with the complexity of the saturated zone. The staff will confirm that acceptable procedures were used by the licensee or responsible party to collect, preserve, and analyze samples. Staff will determine that adequate quality control was used for the collection, preservation, and laboratory analyses of samples. The staff will evaluate the adequacy of non-licensee-constructed monitoring devices used in the characterization (including the characterization of seeps, springs, and private, municipal, or industrial wells in the vicinity of the proposed site). The staff will evaluate aquifer tests performed by the licensee or responsible party to ensure that applicable test methods incorporate proper assumptions, analyses, and test procedures. The staff will assess the accuracy of the transmissivity, storativity, and hydraulic conductivity results derived from testing. The staff will determine if groundwater will discharge to the surface within the site boundry and if fluctuations in the water table will result in interactions of groundwater with the residual radioactive material. Staff will confirm the description of major hydrologic parameters, aerial extent of aquifers, recharge-discharge zones, flow rates and directions, and travel times, including seasonal fluctuations and long-term trends.

The staff will review the licensee’s or responsible party’s information on the unsaturated zone by evaluating the monitoring program and sample collection procedure. The staff will evaluate the rationale for choosing particular sampling locations and verify that they are commensurate with the complexity of the unsaturated zone. The staff will confirm that the description of the unsaturated zone incorporates the necessary field and laboratory data, including seasonal fluctuations and long-term trends. The staff will review the licensee’s analysis of the likelihood of the development of perched aquifers and perform independent analyses, using accepted methods, to determine the adequacy of the description.

The evaluations described in the following paragraphs may be included in the groundwater hydrology portion or dose modeling sections of the of the decommissioning plan.

The staff will evaluate the licensee’s conceptual model that describes, to the extent practicable, all hydrogeologic processes and features, including the potential for deep percolation, recharge/discharge zones, areas of anomalous physical parameters affecting regional processes, extent of aquifers and confining layers, interactions between aquifers, and movement of groundwater in the saturated and unsaturated zone. The staff will review this model to determine its defensibility, conservatism, and adequate incorporation of data into a unified conceptual model.

The staff will evaluate the numerical analyses of groundwater data collected by the licensee or responsible party for the site and vicinity. This will normally involve analytical or numerical modeling. The staff will verify that the model type chosen for analysis is properly documented, verified, and calibrated and adequately simulates the physical system of the site and vicinity. The staff’s will review the modeling strategy used by the licensee or responsible party to assure that it is logical and defensible. The staff will review the adequacy of the model input data generation and reduction techniques. Modifications of input data required for calibration will be reviewed to ensure that the new values are realistic and defensible. Following its review of this information, the staff will determine whether the licensee’s or responsible party’s conclusions are adequate. Alternatively, the staff may decide to conduct an independent analysis. If the staff conducts an independent analysis, it will compare the results with those derived by the licensee or responsible party to determine if the licensee's results are adequate.

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

3.8 NATURAL RESOURCES

The purpose of the review of the license’s description of natural resources at the site is to aid the staff in evaluating the impacts that the decommissioning alternative chosen by the licensee may have on these resources and to evaluate whether the exploitation of these resources could impact on the licensee’s or responsible party’s dose estimates for the site.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine what natural resources are present at and in the vicinity of the site. The staff's review should verify that the following information is included in the natural resources section of the decommissioning plan:

- A description of the natural resources occurring at or near the site, including metallic and nonmetallic minerals and ores; fuels, such as peat, lignite, and coal; hydrocarbons, including gas, oil, tar sands, and asphalt; geothermal resources; industrial mineral deposits, such as sand and gravel, clays, aggregate sources, shales, and building stone; timber; agricultural lands; and waters in the form of brines;

- A description of potable, agricultural, or industrial ground or surface waters including information on resource type, occurrence, location, extent, net worth, recoverability, and current and projected use;

- A description of economic, marginally economic, or subeconomic known or identified natural resources as defined in U.S. Geological Survey Circular 831; and

- Mineral, fuel, and hydrocarbon resources near and surrounding the site which, if exploited, would effect the licensee' or responsible party's dose estimates.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted", above is included in the licensee's or responsible party's description of the natural resources at the site.

The staff will determine if the licensee or responsible party has identified known resources as described in U.S. Geological Survey Circular 831. The staff will verify that the decommissioning plan describes economic, marginally economic, and subeconomic known resources as defined in U.S. Geological Survey Circular 831. On the basis of these data, the staff will evaluate the licensees' or responsible party's estimation of potential future exploitation, considering market values and current and projected demand for the resource in question. On the basis of the resources identified, the staff will examine the potential for site disruption resulting from exploration and exploitation techniques including, but not limited to, augering, drilling, shaft mining, strip mining, bulldozing and other excavation, quarrying, bore-hole injection and pumping, uprooting of vegetation, blasting, stream diversion, and dam construction. These techniques are considered for the possibility of direct site intrusion as well as indirect effects such as alternation of groundwater tables or increase in erosion.

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

3.9 ECOLOGY/ENDANGERED SPECIES

The purpose of the review of the license's description of the ecology and endangered species at the site is to determine if the decommissioning alternative chosen by the licensee will have an adverse impact on the ecology or endangered species.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i) and 72.54(g)(1)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine whether the decommissioning alternative chosen by the licensee will have an adverse impact on site ecology or endangered species at the site. The staff's review should verify that the following information is included in the previous burials section of the decommissioning plan:

- A list of commercially or recreationally important invertebrate species known to occur within 5 kilometers (3.1 miles) of the site;

- A list of all commercially important floral species known to occur within 5 kilometers (3.1 miles) of the site

- A list of commercially or recreationally important vertebrate animals known to occur within 5 kilometers (3.1 miles) of the site;

- Estimates of the relative abundance of both commercially and recreationally important game and nongame vertebrates; and

- A list of all endangered species at or within 5 kilometers (3.1 miles) of the site.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of former burials at the site. The staff will review site information provided by the licensee or responsible party in both the decommissioning plan and Environmental Report (ER), if an ER was submitted. The staff will review information on biotic features in the decommissioning plan for completeness based on information provided by the licensee or responsible party, information acquired during site visits, and consultation with appropriate local, State, and Federal agencies, including the U.S. Fish and Wildlife Service and the director of the State fish and wildlife agency. The staff will assess the probable effects of the decommissioning alternative chosen by the licensee or responsible party on these species.

Sample Evaluation Findings

None

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees are also encouraged to submit the information in electronic format.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 4.0
RADIOLOGICAL STATUS OF FACILITY

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the current radiological status of the facility is adequate to allow the staff to fully understand the types and levels of radioactive material contamination and the extent of radioactive material contamination at the facility. This information will be used by the staff during its review of the licensee's or responsible party's decommissioning activities, to evaluate the cost estimates for decommissioning, and decommissioning health and safety plans. This information should include summaries of the types and extent of radionuclide contamination in all media at the facility including buildings, systems and equipment, surface and subsurface soil, and surface and groundwater.

Information presented in this section of the SRP should be developed based on the methodologies and procedures described in Section 14 of this SRP (Facility Radiation Surveys). Information describing how the licensee or responsible party developed the information presented in this section should be presented in the "Facility Radiation Surveys" section of the decommissioning plan. If the licensee or responsible party combines the description of how the radiological status of the facility was determined with the results of the evaluation discussed below, NRC staff shall evaluate the licensee's methodology using Section 14.2 of this SRP. Note that Section 14.2 also contains requirements for reporting the results of characterization surveys. Licensees that report the results of the characterization survey in the “Radiological Status of Facility” portion of the decommissioning plan do not need to report it in the “Facility Radiation Surveys” portion of the decommissioning plan. Similarly, licensees may combine the information in this section of the SRP with that described in the “Facility Radiation Surveys” section, as long as the information discussed in both sections is included in the decommissioning plan.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under “Areas of Review,” above. Staff will review the radiological status portion of the decommissioning plan without assessing the technical accuracy or completeness of the information. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under “Areas of Review,” above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is both technical and informational in nature. The staff will verify that the licensee or responsible party has summarized the radiological status of all buildings and equipment, surface and subsurface soil, and ground and surface water at the site.

4.1 CONTAMINATED STRUCTURES

The purpose of the review of the description of the contaminated structures is to evaluate whether the licensee has fully described the types and activity of radioactive material contamination in the structures, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the structures, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the structure, whether the licensee’s or responsible party’s waste management practices are appropriate, and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Note that, in some instances licensees may choose to dismantle contaminated structures and dispose of the building debris as radioactive waste in lieu of decontaminating the building. Similarly, licensees may choose to decontaminate portions of buildings to levels appropriate for unrestricted use and dismantle portions of the building to gain access to areas where contamination has migrated, such as floor/wall joints. In these instances, all of the information described below may not necessarily need to be included in the decommissioning plan. NRC staff should discuss these activities with these licensees to ensure that adequate information is provided in the decommissioning plan to allow the staff to perform the evaluations described above, without requiring the licensee to expend substantial resources characterizing the structures.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i)(i), and 72.54(g)1

Regulatory Guidance

- “Draft Branch Technical Position on Site Characterization for Decommissioning”
- NUREG-1575 - “Multi-Agency Radiological Survey and Site Investigation Manual”
- NUREG 1754 - “Technology, Safety and Costs of Decommissioning Reference Non-Fuel Cycle Nuclear Facilities,” Addendum 1

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material contamination in the structure, as well as the extent of this contamination. The staff’s review should verify that the following information is included in the contaminated structures section of the facility decommissioning plan:

- A list or description of all structures at the facility where licensed activities occurred that contain residual radioactive material in excess of site background levels;

- A summary of the structures and locations at the facility that the licensee or responsible party has concluded have not been impacted by licensed operations and the rationale for the conclusion;

- A list or description of each room or work area within each of these structures;

- A summary of the background levels used during scoping or characterization surveys;

- A summary of the locations of contamination (i.e., walls, floors, wall/floor joints, structural steel surfaces, ceilings, etc.) in each room or work area;

- A summary of the radionuclides present at each location, the maximum and average radionulide activities in disintegrations per minute per 100 square centimeters (dpm/100cm^2) the chemical form of the radionuclide, and, if multiple radionuclides are present, the radionuclide ratios;

- The mode of contamination for each surface (i.e., whether the radioactive material is present only on the surface of the material or if it has penetrated the material);

- The maximum and average radiation levels in millirem per hour (mrem/hr) or microrem per hour (µrem/hr), as appropriate, in each room or work area; and

- A scale drawing or map of the rooms or work areas showing the locations of radionuclide material contamination and radiation levels. All maps should include compass direction indicators.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of the contaminated structures. The staff’s review should verify that the licensee has fully described the types and activity of radioactive material contamination in facility structures, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the structures, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the structures, whether the licensee’s or responsible party’s waste management practices are appropriate, and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Sample Evaluation Findings

The staff may combine the evaluation finding for the licensee’s or responsible party’s description of contaminated structures with the findings for the remaining areas in this section of the SRP as follows:

The NRC staff has reviewed the information in the “Facility Radiological Status” section of the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 4 (“Radiological Status of Facility”). Based on this review, the NRC staff has determined that the licensee [insert name] has described the types and activity of radioactive material contamination at its facility sufficiently to allow the NRC staff to evaluate the potential safety issues associated with remediating the facility, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present at the facility, whether the licensee’s or responsible party’s waste management practices are appropriate, and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. The information may be summarized in narrative format. However, licensees are encouraged to present the material in tabular format, to the maximum extent possible. Licensees should be encouraged to submit the information in electronic format.

4.2 CONTAMINATED SYSTEMS AND EQUIPMENT

The purpose of the review of the description of the contaminated systems and equipment at the facility is to evaluate whether the licensee has fully described the types and activity of radioactive material contamination in facility systems or on equipment, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the systems or equipment, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the systems or equipment, whether the licensee's or responsible party's waste management practices are appropriate and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Note that, in some instances, licensees may choose to remove and dispose (either as radioactive waste or as usable equipment in another radiation area) of contaminated systems and/or equipment, in lieu of decontaminating the system or equipment. In these instances, all of the information described below may not necessarily need to be included in the decommissioning plan. NRC staff should discuss these activities with licensees to ensure that adequate information is provided in the decommissioning plan to allow the staff to perform the evaluations described above, without requiring the licensee to expend substantial resources characterizing the equipment or system.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 10 CFR 40.42(g)(4)(i), 10 CFR 70.38(g)(4)(i), 10 CFR 72.54(g)1

Regulatory Guidance

- Draft Branch Technical Position on Site Characterization for Decommissioning
- NUREG-1575 - Multi-Agency Radiological Survey and Site Investigation Manual
- NUREG 1754 - Technology, Safety and Costs of Decommissioning Reference Non-Fuel Cycle Nuclear Facilities, Addendum 1

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material contamination present in systems or on equipment, as well as the extent of this contamination. The staff's review should verify that the following information is included in the contaminated systems and equipment section of the facility decommissioning plan:

- A list or description and the location of all systems or equipment at the facility that contain residual radioactive material in excess of site background levels;
- A summary of the radionuclides present in each systems or on the equipment at each location, the maximum and average radionulide activities in dpm/100cm^2, the chemical form of the radionuclide, and, if multiple radionuclides are present, the radionuclide ratios;
- The maximum and average radiation levels in mrem/hr, or µrem/hr, as appropriate, at the surface of each piece of equipment;
- A summary of the background levels used during scoping or characterization surveys; and
- A scale drawing or map of the rooms or work areas showing the locations of the contaminated systems or equipment. All maps should include compass direction indicators.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above is included in the licensee's description of the contaminated systems or equipment. The staff's review should verify that the licensee has fully described the types and activity of radioactive material contamination in the facility systems or on equipment, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the systems or equipment, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the systems or equipment, whether the licensee's or responsible party's waste management practices are appropriate and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of contaminated systems or equipment with the findings for the remaining areas in this section of the SRP (see Section 4.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. The information may be summarized in narrative format. However, licensees should be encouraged to present the material in tabular format to the maximum extent possible. Licensees should be encouraged to submit the information in electronic format.

4.3 SURFACE SOIL CONTAMINATION

The purpose of the review of the description of surface soil (i.e., soil within the top 15-30 centimeters (cm) of the soil column) contamination is to determine if the licensee has fully described the types and activity of radioactive material contamination in the surface soil, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the surface soil, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the surface soil, whether the licensee's or responsible party's waste management practices are appropriate and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated soil that will need to be removed or remediated.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 10 CFR 40.42(g)(4)(i), 10 CFR 70.38(g)(4)(i), 10 CFR 72.54(g)1

Regulatory Guidance

- "Draft Branch Technical Position on Site Characterization for Decommissioning"
- NUREG-1575 - "Multi-Agency Radiological Survey and Site Investigation Manual"
- NUREG 1754 - "Technology, Safety and Costs of Decommissioning Reference Non-Fuel Cycle Nuclear Facilities," Addendum 1

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material in surface soil, as well as the extent of this contamination. The staff's review should verify that the following information is included in the description of contaminated surface soil in the facility decommissioning plan:

- A list or description of all locations at the facility where surface soil contains residual radioactive material in excess of site background levels;

- A summary of the background levels used during scoping or characterization surveys;

- A summary of the radionuclides present at each location, the maximum and average radionuclide activities in picoCuries per gram (pCi/gm), the chemical form of the radionuclide, and, if multiple radionuclides are present, the radionuclide ratios;

- The maximum and average radiation levels in mrem/hr at each location; and

- A scale drawing or map of the site showing the locations of radionuclide material contamination in surface soil. All maps should include compass direction indicators.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above is included in the licensee’s description of the surface soil contamination at the facility. The staff’s review should verify that the licensee has fully described the types and activity of radioactive material contamination in the surface soil at the facility, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the soil, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the soil, whether the licensee’s or responsible party’s waste management practices are appropriate and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of surface soil contamination with the findings for the remaining areas in this section of the SRP (see Section 4.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. The information may be summarized in narrative format. However, licensees are encouraged to present the material in tabular format to the maximum extent possible. Licensees should be encouraged to submit the information in electronic format.

4.4 SUBSURFACE SOIL CONTAMINATION

The purpose of the review of the description of subsurface soil (i.e., soil below the top 15 -30 cm of soil in the soil column) contamination is to determine if the licensee has fully described the types and activity of radioactive material contamination in the subsurface soil, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the subsurface soil, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the subsurface soil, whether the licensee's or responsible party's waste management practices are appropriate and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated soil that will need to be removed or remediated.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 10 CFR 40.42(g)(4)(i), 10 CFR 70.38(g)(4)(i), 10 CFR 72.54(g)1

Regulatory Guidance

- "Draft Branch Technical Position on Site Characterization for Decommissioning"
- NUREG 1754 - "Technology, Safety and Costs of Decommissioning Reference Non-Fuel Cycle Nuclear Facilities," Addendum 1
- Appendix E of this SRP

Note that MARSSIM may be revised in the future to better describe acceptable methods to evaluate subsurface soil. This SRP and Appendix E will be revised to reflect any changes to MARSSIM when they are finalized.

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material in subsurface soil, as well as the extent of this contamination. The staff's review should verify that the following information is included in the description of contaminated subsurface soil in the facility decommissioning plan:

- A list or description of all locations at the facility where subsurface soil contains residual radioactive material in excess of site background levels;

- A summary of the background levels used during scoping or characterization surveys;

- A summary of the radionuclides present at each location, the maximum and average radionulide activities in pCi/gm, the chemical form of the radionuclide, and, if multiple radionuclides are present, the radionuclide ratios;

- The depth of the subsurface soil contamination at each location; and

- A scale drawing or map of the site showing the locations of subsurface soil contamination. All maps should include compass direction indicators.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above is included in the licensee’s description of the subsurface soil contamination at the facility. The staff’s review should verify that the licensee has fully described the types and activity of radioactive material contamination in the subsurface soil at the facility, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the subsurface soil, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the subsurface soil, whether the licensee’s or responsible party’s waste management practices are appropriate and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of subsurface soil contamination with the findings for the remaining areas in this section of the SRP (see Section 4.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. The information may be summarized in narrative format. However, licensees should be encouraged to present the material in tabular format to the maximum extent possible. Licensees should be encouraged to submit the information in electronic format.

4.5 SURFACE WATER

The purpose of the review of the description of contaminated surface water is to evaluate whether the licensee has fully described the types and activity of radioactive material present in surface water bodies at the facility, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate potential safety issues associated with remediating the surface water, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the surface water, whether the licensee’s or responsible party’s waste management practices are appropriate and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated water that will need to be removed or remediated.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i), and 72.54(g)1

Regulatory Guidance

- “Draft Branch Technical Position on Site Characterization for Decommissioning”

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material contamination in surface water at the facility, as well as the extent of this contamination. The staff’s review should verify that the following information is included in the description of surface water contamination in the decommissioning plan:

- A list or description and map of all surface water bodies at the facility that contain residual radioactive material in excess of site background levels;

- A summary of the background levels used during scoping or characterization surveys; and

- A summary of the radionuclides present in each surface water body and the maximum and average radionuclide activities in picoCuries per liter (pCi/l).

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of the surface water contamination at the site. The staff’s review should verify that the licensee has fully described the types and activity of radioactive material contamination in the surface water at the site, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate potential safety issues associated with remediating the surface water, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the water, whether the licensee’s or responsible party’s waste management practices are appropriate and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of contaminated surface water with the findings for the remaining areas in this section of the SRP. (See section 4.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

2. The information may be summarized in narrative format. However, licensees are encouraged to present the material in tabular format to the maximum extent possible. Licensees should be encouraged to submit the information in electronic format.

4.6 GROUNDWATER

The purpose of the review of the description of contaminated groundwater is to evaluate whether the licensee has fully described the types and activity of radioactive material present in groundwater at the facility, as well as the extent of this contamination. This information should be sufficient to allow the NRC staff to evaluate potential safety issues associated with remediating the groundwater, whether the remediation activities and radiation control measures proposed by the licensee or responsible party (described in Sections 8 and 10 of this SRP) are appropriate for the type of radioactive material present in the groundwater, whether the licensee's or responsible party's waste management practices are appropriate and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated water that will need to be removed or remediated.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 10 CFR 40.42(g)(4)(i), 10 CFR 70.38(g)(4)(i), 10 CFR 72.54(g)1

Regulatory Guidance

- "Draft Branch Technical Position on Site Characterization for Decommissioning"

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive material contamination in groundwater at the facility, as well as the extent of this contamination. The staff's review should verify that the following information is included in the description of groundwater contamination in the decommissioning plan:

- A summary of the aquifer(s) at the facility that contain residual radioactive material in excess of site background levels;
- A summary of the background levels used during scoping or characterization surveys; and
- A summary of the radionuclides present in each aquifer and the maximum and average radionulide activities in pCi/l.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of the groundwater contamination at the site. The staff’s review should verify that the licensee has fully described the types and activity of radioactive material contamination in the groundwater at the site, as well as the extent of this contamination. These descriptions should be sufficient to allow the NRC staff to evaluate the potential safety issues associated with remediating the groundwater, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present in the groundwater, whether the licensee’s or responsible party’s waste management practices are appropriate and whether the licensee’s or responsible party’s cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of contaminated groundwater with the findings for the remaining areas in this section of the SRP. (See section 4.1)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. The information may be summarized in narrative format. However, licensees are encouraged to present the material in tabular format to the maximum extent possible. Licensees should be also encouraged to submit the information in electronic format.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 5.0
DOSE MODELING EVALUATIONS

INTRODUCTION

Nearly every licensee that submits a decommissioning plan will need to provide the NRC with estimates of the potential future dose that could be caused by the residual radioactivity remaining on the site after decommissioning activities are completed. The use of a dose limit allows both the licensee and regulator to take site-specific information into account in determining acceptable concentrations of residual radioactivity at the site using dose models and exposure scenarios that are as realistic as necessary. This SRP module has been written to maintain this flexibility. It includes the review procedures, acceptance criteria, and evaluation findings necessary to review the licensee's dose analyses, and has been subdivided into four major sections, based on the overall decommissioning goal:

SRP 5.1, "Unrestricted release using screening criteria;"
SRP 5.2, "Unrestricted release using site-specific information;"
SRP 5.3, "Restricted release;" and
SRP 5.4, "Alternate release criteria."

In certain cases, if different potential decommissioning options are explored by the licensee, the staff may need to use more than one of these sections in reviewing the decommissioning plan. This SRP module reflects the staff-preferred approaches; other approaches can be acceptable with sufficient justification.

NUREG-1549 provides the licensees with guidance on how to perform iterative dose analysis using the "Decommissioning Framework" (Figure 5.0 -1), which generalizes the entire decommissioning process (e.g., Step 7 includes final status survey and other requirements related to license termination). The staff's review divides dose modeling into four general parts:

(1) Source term assumptions;
(2) An exposure scenario considering the site environment;
(3) The mathematical model/computational method used ; and
(4) The parameter values and a measure of their uncertainty.

The actions taken as part of the loop suggested by Steps 8 through 12 can result in the licensee modifying one or more of the above four parts.

The staff will need to review all of the dose modeling information submitted by the licensee or responsible party. For certain cases, such as screening analyses using default values or a look-up table, most of the review has already been completed in developing these tools and, therefore, the licensee need only submit minimal site information and justification in using these models, parameters, and exposure scenarios. Two general approaches exist to provide reasonable assurance that the final concentrations will meet the dose criterion.

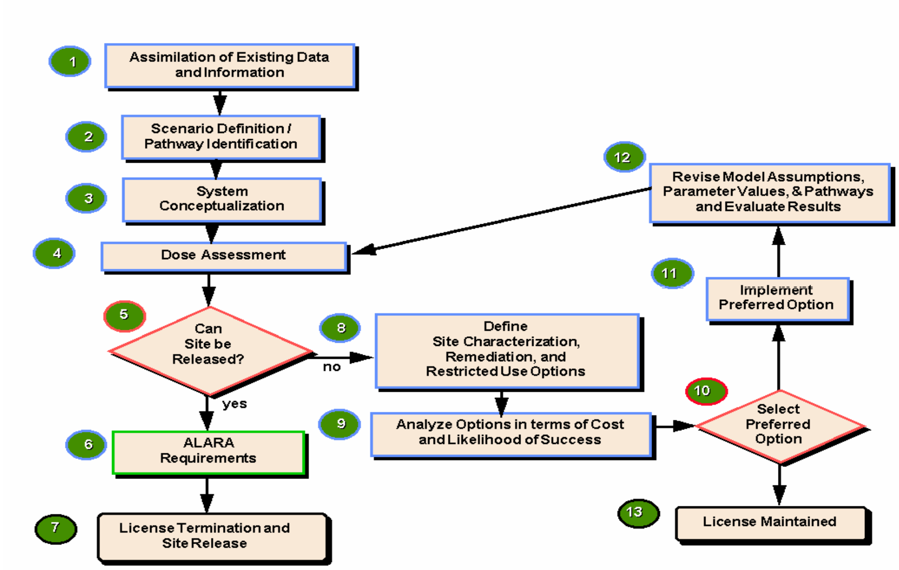

Figure 5.0.1. Decommissioning Framework (from NUREG-1549)

(1) The licensee can commit to the scenario(s), model(s), and parameters to be used to evaluate compliance with the dose criterion using the final concentrations. The licensee will need to project expected final concentrations in the decommissioning plan to show that there is reasonable assurance that the dose criterion will be met at the time of license termination.

(2) The licensee can derive, and commit to, nuclide-specific concentration limits equivalent to the dose limit.

<u>General Approach for Dose Modeling</u>

The following section discusses the basic components that are involved in a dose modeling assessment. It is meant to provide readers with an overview of how the pieces fit together. This discussion should provide both licensees and reviewers with an understanding of the "big picture," while the review components in the following sections focus more on the staff reviewing details of each part of the dose assessment.

SRP Modules 4 ("Facility Radiological Status") and 14 ("Facility Radiation Surveys") address the residual radioactivity currently present at the site, radiological surveys, and the concentration limits, known as Derived Concentration Guideline Limits (DCGLs), that will be used by the licensee during the decommissioning. The information is based on measurements and knowledge of the site history. To perform dose modeling, the licensee will need to use the site information on residual radioactivity expected to be present at the completion of decommissioning, to develop a generalized view of the site's source term. In developing the source term model, the licensee needs to consider the site measurements, the intended remedial actions, and the needs of the conceptual model.

For example, a site may have a large number of both historical and current measurements characterizing the residual radioactivity over a 10-hectare (25-acre) site. If the site information shows that residual radioactivity levels do not vary significantly, the licensee may assume that the source term is a uniform layer of residual radioactivity over the site. If the site information shows that most of the residual radioactivity is concentrated in a small area of the site, which may be due to either uneven contamination resulting from a single source or from multiple sources, the licensee may visualize the site as two sources of residual radioactivity, for purposes of dose modeling: (1) a uniform concentrated source over the smaller area where the assumed concentration is based on that area's measurements, and (2) a second source that uniformly covers the rest of the affected area at some lower concentration.

After a source term model has been developed, the question becomes: "How could humans be exposed either directly or indirectly to residual radioactivity?" or "What is the appropriate exposure scenario?" Each exposure scenario must address the following questions:

(1) How does the residual radioactivity move through the environment?

(2) Where can humans be exposed to the environmental concentrations?

(3) What are the exposure group's habits that will determine exposure? (e.g., what do they eat and where does it come from? How much? Where do they get water and how much? How much time do they spend on various activities? etc.)

In most situations, there are numerous possible scenarios of how future human exposure groups could interact with residual radioactivity. The compliance criteria in 10 CFR Part 20 for decommissioning does not require an investigation of all (or many) possible scenarios; its focus is on the dose to members of the critical group. The critical group is defined (at 10 CFR 20.1003) as "the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances."

By combining knowledge about the answers to (1) and (2), the analyst can develop exposure pathways. Exposure pathways are the routes that residual radioactivity travels through the environment, from its source, until it interacts with a human. They can be fairly simple (e.g., surface soil residual radioactivity emits gamma radiation which results in direct exposure to the individual standing on the soil) or they can be fairly involved (e.g., the residual radioactivity in the surface soil leaches through the unsaturated soil layers into underlying aquifer, and the water from the aquifer is pumped out by the exposed individual for use as drinking water, which results in the exposed individual ingesting the environmental concentrations). Exposure pathways typically fall into three principal categories identified by the manner in which the exposed individual interacts with the environmental concentrations resulting from the residual radioactivity: ingestion, inhalation, or external (i.e., direct) exposure pathways.

The exposure pathways for many of the exposure groups can be bounded by a smaller number of possible exposure groups. For example, at a site with surface soil contamination, two possible exposure groups are a gardener who grows a small fraction of his or her fruits and vegetables in the soil, and a resident farmer who grows a larger fraction of his or her own food, supplying not only vegetables but also meat and milk. In this case, the resident farmer bounds the gardener exposure group (because it both incorporates the gardener's pathways but also includes other routes of exposure) and, therefore, the gardener exposure group does not need to be analyzed and the compliance calculation's scenario would involve the resident farmer.

As required under 10 CFR 20.1302(b), expected doses are evaluated for the average member of the critical group, which is not necessarily the same as the maximally exposed individual. This is not a reduction in the level of protection provided to the public, but an attempt to emphasize the uncertainty and assumptions needed in calculating potential future doses, while limiting boundless speculation on possible future exposure scenarios. While it is possible to actually identify with confidence the most exposed member of the public in some operational situations (through monitoring, time-studies, distance from the facility, etc.), identification of the specific individual who will receive the highest dose some time (up to 1000 years) in the future is impractical, if not impossible. Speculation on his or her habits, characteristics, age, or metabolism could be endless. The use of the "average member of the critical group" acknowledges that any hypothetical "individual" used in the performance assessment is based, in some manner, on the statistical results from data sets (e.g., the breathing rate is based on the range of possible breathing rates) gathered from groups of individuals. While bounding assumptions could be used to select values for each of the parameters (i.e., the maximum amount of meat, milk, vegetables, possible exposure time, etc.), the result could be an extremely conservative calculation of an unrealistic scenario and may lead to excessively low allowable residual radioactivity levels.

Calculating the dose to the critical group is intended to bound the individual dose to other possible exposure groups because the critical group is a relatively small group of individuals, due to their habits, actions, and characteristics, who could receive among the highest potential dose at some time in the future. By using the hypothetical critical group as the dose receptor, coupled with prudently conservative models, it is highly unlikely that any individual would actually receive doses in excess of that calculated for the average member of the critical group. The description of a critical group's habits, actions, and characteristics should be based on credible assumptions and the information or data ranges used to support the assumptions should be limited in scope to reduce the possibility of adding members of less exposed groups to the critical group. An analysis of the average member of the critical group's potential exposure should also include, in most cases, some evaluation of the uncertainty in the parameter values used to represent physical properties of the environment.

When calculating for compliance with the requirements of Subpart E of Part 20, the intake-to-dose conversion factors used to calculate internal exposures can be found in Federal Guidance Report No. 11,[1] which are based primarily on adults. As stated in the Environmental Protection Agency's Federal Register notice (*FR* 66414, Dec. 23, 1994) on "Federal Radiation Protection

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[1] Eckerman, Keith F., *et al.* "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," U.S. Environmental Protection Agency, Federal Guidance Report No. 11 (EPA-520/1-88-20), September 1988.

Draft Guidance for Exposure of the General Public," which proposes a public dose limit of 1 mSv (100 mrem) per year from all sources:

> These dose conversion factors are appropriate for application to any population adequately characterized by the set of values for physiological parameters developed by the [International Committee on Radiological Protection] and collectively known as "Reference Man." The actual dose to a particular individual from a given intake is dependent upon age and sex, as well as other characteristics. As noted earlier, implementing limits for the general public expressed as age and sex dependent would be difficult....More importantly, the variability in dose due to these factors is comparable in magnitude to the uncertainty in our estimates of the risks which provide the basis for our choice of the [public dose limit]. For this reason EPA believes that, for the purpose of providing radiation protection under the conditions addressed by these recommendations, the assumptions exemplified by Reference Man adequately characterize the general public, and a detailed consideration of age and sex is not generally necessary. (FR 66423, Dec. 23, 1994) (sic)

Since age-based dose conversion factors are not being used, all individuals are assumed to have the same dose conversion factors. Because of this, only in very rare scenarios (generally, single exposure pathway scenarios) will a non-adult individual intake more radionuclides, thereby resulting in a higher dose, than an adult in a similar exposure scenario. One example is the milk pathway, generally, children drink more milk annually than adults. If milk was the only pathway that would expose the individual to a dose, then the child would have a slightly higher dose than the adult. But in most situations, especially ones involving multiple pathways, the total intake of the adult is greater than that of a child. Therefore, the average member of the critical group should be assumed to be an adult, with the proper habits and characteristics of an adult.

By integrating the exposure scenario, source term, and knowledge about the applicable environmental transport routes involved in the exposure pathways, a conceptual model of the features and processes at the site can be created. The conceptual model is a qualitative description of the important environmental transport and exposure pathways and their interrelationships. Using this description, a mathematical model quantifying it, or using an off-the-shelf computer code that implements the same (or similar) conceptual model, needs to be identified. Generally, a single mathematical model can be used for several different conceptual models by varying either the boundary conditions or the various parameters.

Going from a conceptual model to a mathematical model involves a number of assumptions and simplifications. For example, one part of a conceptual model of surface soil contamination involves the leaching of radionuclides through the soil and into the aquifer. In reality, the soil between the surface and the aquifer is usually formed by numerous layers of different types of soils with varying thickness across a site. For the purposes of dose modeling, the conceptual model is more focused on knowing how much activity is entering (and leaving) each major environmental compartment (such as the aquifer) than to precisely predict the level of activity in the intervening material (e.g., any single soil layer between the surface and the aquifer). Therefore, the mathematical model may view the intervening soil layers as one layer or just a few layers, depending on the difficulty of justifying effective parameters that will mimic the real behavior. Users of off-the-shelf codes should be aware of and consider the appropriateness of the assumptions made in the computer model they are using.

Selection of parameter values (or ranges) for features, events, and processes depends not only on the site conditions and the exposure scenario, but also on the computer code (or mathematical model) being used. Nearly any data set will need to be transformed into one appropriate to the situation. This can be as straightforward as generating a site-wide effective soil density value or as complex as converting resuspension factor data into resuspension rates. The NRC has already factored these sort of issues in the data used in the screening analyses, but licensees using site-specific information will need to justify their values.

In the past, the most common computer codes were deterministic and did not explicitly calculate parameter uncertainty. Although it is not always necessary for a licensee to use a probabilistic[2] code to evaluate parameter uncertainty, for site-specific analyses, licensees will need to provide some discussion of the level of uncertainty in the results. It should be noted that the uncertainty of prime interest to the staff is uncertainty in the physical parameters.

Scoping Review

As part of the decommissioning plan review, the staff should evaluate the basis for each of the calculated doses used by the licensee in the various decommissioning options. The staff should organize this review by first looking at the overall scope of the dose modeling contained in the decommissioning plan (possibly for several decommissioning options and/or critical groups). This scoping review will help the staff identify which specific dose modeling SRP sections are applicable for a given decommissioning plan. After the scoping review, the staff will review each of the scenarios that the licensee or responsible party is using to show compliance with the regulations.

An acceptable way to organize the scoping review is to: (1) identify and confirm the principal sources (before and after remediation) of residual radioactivity; and (2) identify the decommissioning goal of the decommissioning plan. Coupling the two sets of information, the staff should have a good indication of the appropriate SRP sections. For decommissioning goals involving unrestricted release, the staff will need to quickly evaluate whether the licensee only used default parameters or published look-up tables instead of incorporating site-specific information. Section 5.1 of this SRP module is not significantly different from Section 5.2 in overall acceptance criteria, but most of the review of the acceptance criteria in Section 5.2 has been previously completed by the staff and is incorporated in the default screening methods.

Next, the staff should first verify that conditions at the site are commensurate with the approach chosen by the licensee or responsible party (i.e., whether the licensee may use a screening analysis approach or whether site-specific dose modeling must be performed). Licensees or

[2] In this SRP, the term “probabilistic” refers to a computer code or analysis that uses a random sampling method to select parameter values. The result of the calculation does not include the probability of the scenario occurring.

responsible parties may not be able to use a screening analysis approach at sites exhibiting any of the following conditions (excluding those caused by sources of background radiation):

(1) Soil contamination greater than 30 cm (12 inches) below the ground surface;

(2) Radionuclide residual radioactivity present in an aquifer;

(3) Buildings with volumetrically contaminated material;

(4) Radionuclide concentrations in surface water sediments; and

(5) Sites that have an infiltration rate that is greater than the vertical saturated hydraulic conductivity (i.e., resulting in the water running off the surface rather than purely seeping into the ground).

These are limitations caused by the conceptual models used in developing the screening analysis. In other words, the conceptual model, parameters, and scenarios in the DandD computer code are generally incompatible with such conditions. Situations do exist where you can still utilize the analyses using scenario assumptions to modify the source term. For example, by assuming buried radioactive material is excavated and spread across the surface, the screening criteria may be applicable for use at the site..

When evaluating any decommissioning option that has a goal of terminating the license under the unrestricted release requirements of 10 CFR 20.1402, the primary scenarios generally involve individuals exposed on the site. The default exposure scenario for residual radioactivity in the environment (versus building surfaces) is usually some sort of residential farmer, because this group usually includes a nearly comprehensive number of exposure pathways. Site conditions, such as soil type, or groundwater quality or other use scenarios, may remove potential exposure pathways from consideration with the appropriate level of justification by the licensee.

A decommissioning option that results in the license being terminated under the restricted use provisions of 10 CFR 20.1403 will require, at a minimum, two different exposure scenarios. One scenario will evaluate the performance of the proposed restrictions by assuming these restrictions never fail. Depending on where the residual radioactivity is and what the proposed restrictions are, the exposure location(s) for the critical group could be on-site or off-site. The second scenario will be performed similarly to the analyses for unrestricted release, in which it assumes that the restrictions put in place by the licensee have failed to work properly (or effectively), and the site will be used without knowledge of the presence of residual radioactivity.

5.1 UNRESTRICTED RELEASE USING SCREENING CRITERIA

The staff will review the information provided in the decommissioning plan pertaining to the licensee's assessment of the potential doses resulting from the residual radioactivity remaining at the end of the decommissioning process. The findings and conclusions of the review under this SRP will be used to evaluate the compliance with the NRC's dose limit. This SRP section addresses decommissioning options involving unrestricted release using the default screening models/tables. SRP sections for other decommissioning approaches are provided in subsequent sections.

The SRP sections for screening analyses have been divided into two categories based on the location of the residual radioactivity:

(1) SRP 5.1.1, "Building Surface Residual Radioactivity;" and

(2) SRP 5.1.2, "Surface Soil Residual Radioactivity."

5.1.1 UNRESTRICTED RELEASE USING SCREENING CRITERIA FOR BUILDING SURFACE RESIDUAL RADIOACTIVITY

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information provided in the decommissioning plan pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process. The findings and conclusions of the review under this SRP will be used to evaluate the decommissioning plan's compliance with 10 CFR 20.1402. The staff will review the information provided to support the dose assessment from residual radioactivity on building surfaces. For decommissioning alternatives using the default screening criteria, the staff should ensure that source term information, including nuclides of interest, configuration of source, and source spatial variability, etc; and, output reports from the DandD code (if calculations were performed in lieu of look up tables used) or calculations of the sum of fractions, if necessary, are included in the decommissioning plan. The staff will review the assumptions regarding the source term for both fixed and potentially removable residual radioactivity and, the applicability of the default building scenario, and verify that the default parameters (or parameter ranges) were used.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review information pertaining to the dose modeling of building surfaces in the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature and the staff will review the information provided by the licensee to ensure that the licensee used the default screening analyses or published tables, appropriately. The staff will also verify that the licensee provided enough information to allow an evaluation of the appropriateness of using this approach and any assumptions used in characterizing the source term. Proper use of the screening approach will provide reasonable assurance that the decommissioning option will comply with regulations.

CALCULATION OF RADIOLOGICAL IMPACTS ON INDIVIDUALS

The overall objective of the staff's review is to determine if the screening criteria were used correctly by the licensee and whether the calculations provide reasonable assurance that potential doses would not exceed the dose limits. Specific impacts to be calculated include those associated with exposures using the default building scenario and model.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1402

Regulatory Guidance

- Appendix C of this SRP.
- NUREG-1549, “Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.”
- Draft NUREG/CR-5512, Volume 3, “Residual Radioactive Contamination From Decommissioning: Parameter Analysis.”

Information to be Submitted

The staff should organize this review by first looking at the overall scope of the dose modeling contained in the decommissioning plan (possibly for several decommissioning options and/or critical groups). This scoping review, discussed in SRP 5.0, will help the reviewers identify which SRPs are applicable for a given decommissioning plan. After the scoping review, the staff will review each of the scenarios that the licensee is using to show compliance with the regulations using the appropriate review section.

The licensee’s or responsible party’s dose modeling for building surfaces should include the following:

- The general conceptual model (for both the source term and the building environment) of the site; and,

- A summary of the screening method (i.e., running DandD or using the look-up tables) used in the decommissioning plan.

EVALUATION FINDINGS

Evaluation Criteria

When licensees use the default screening methods and parameters inherent in the DandD code by either running the computer code or using look-up tables, the review and acceptance of nearly all areas of the analysis have already been done by NRC staff in developing the screening tool and reviewers will only need to review the source term model and the overall applicability of using the screening method with the associated residual radioactivity.

The staff will determine the acceptability of the licensee’s projections of: (1) radiological impacts on future individuals from residual radioactivity; and (2) compliance with regulatory criteria. The information in the decommissioning plan may be considered acceptable if it is sufficient to ensure a reasonable assessment of the possible future impacts from the residual radioactivity on building surfaces. The information must allow an independent staff evaluation of the justifications and assumptions used.

The staff will review the following information, as necessary, for each dose assessment of residual radioactivity on building surfaces that the licensee has submitted in the various decommissioning options. If the licensee did not directly calculate the dose from residual radioactivity, but instead either derived, or proposes to use, unit concentration values, the staff needs only to review the information on the configuration of the residual radioactivity and the appropriate screening criteria section, below. Review of the spatial variability will be performed as part of the final survey. For additional review guidance, the staff is directed to the SRP's Appendix C, Section 2.

- Source Term Configuration

  The staff will confirm that the actual measurements, facility history, and planned remedial action(s) support the source term configuration used in the modeling by reviewing the information in the facility history, radiological status, and planned remedial action(s) portions of the decommissioning plan. The reviewer will review both the areal extent of contamination and the depth of penetration of the residual radioactivity into the building surfaces. The reviewer will determine if the physical configuration of the residual radioactivity can adequately be assumed to be a thin layer of residual radioactivity on the building surfaces. If the residual radioactivity is not limited to the building surfaces, then use of the default screening criteria are not warranted without addition justification, and the reviewer should evaluate the modeling using SRP Chapter 5.2.

- Residual Radioactivity Spatial Variability

  The staff will review the information provided by the licensee for conditions both before and those projected after the decommissioning alternative. Based on this information, the staff will determine whether it is appropriate to make an assumption of homogeneity: (1) for the whole facility; or (2) for subsections of the facility. The staff will then review the adequacy of the licensee's determination of a representative value (or range of values) for the residual radioactivity concentration in the source term modeled. To evaluate the final survey, as a general guideline, staff could use the concepts related to area factors included in Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

- Execution of the DandD Computer Code Dose Calculations

  If the licensee has used the DandD computer code to calculate the dose based on either current concentrations or projected final concentrations, the staff will verify that:

  - The residual radioactivity is limited to surface contamination;
  - If the appropriate annual peak dose is greater than 0.025 mSv (2.5 mrem), the removable fraction of the residual radioactivity will be 10 percent or less at the time of license termination;[3]

[3] The DandD default scenario assumes that only 10% of the surface contamination is removable and available for resuspension. Only at 10% of the dose limit does the assumption begin to become important because in the extreme case of 100% removable for radionuclides that produce the majority of dose from the inhalation pathway, the code result may be

– The output reports verify that no parameters (other than source term concentrations) were modified; and
– The licensee has used the 90 percentile of the dose distribution to compare with the dose limit.

- DCGLs From the DandD Code or Look-up Tables

  The licensee may use either the DandD computer code or the published look-up table for beta and gamma emitters (see Appendix C, Section 2) to establish nuclide-specific DCGLs equivalent to 0.25 mSv/y (25 mrem/y). If the licensee is proposing to use radionuclide-specific DCGLs, the staff will verify that:

  – The residual radioactivity is limited to surface contamination;

  – If the residual radioactivity is greater than 10 percent of the respective limit, the removable fraction of the residual radioactivity will be 10 percent or less at license termination; and

  – if more than one radionuclide is involved, there is reasonable assurance that the sum of fractions[4] will be maintained.

  If the licensee has used the DandD Version 2 computer code to calculate the radionuclide-specific DCGLs, the staff will also verify that:

  – The output reports verify that no parameters (other than entering unit concentrations) were modified; and
  – The licensee has used the 90 percentile of the dose distribution to derive the concentrations.

- Compliance with regulatory criteria

  The licensee's projections of compliance with regulatory criteria, if that decommissioning option is pursued, are acceptable provided that the staff has reasonable assurance that:

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underestimating the result by a factor as great as 10.

[4] Determine for each radionuclide the ratio between the concentration present and the respective DCGL. The sum of the ratios for all the radionuclides may not exceed "1" (i.e., unity). For example, if radionuclides "A," and "B" are present at respective concentrations of "Conc A" and "Conc B," and if the respective applicable DCGLs are "Limit A," and "Limit B," then the concentration shall be limited so that the following relationship exists:

$$\frac{Conc\ A}{Limit\ A} + \frac{Conc\ B}{Limit\ B} \leq 1$$

- The only residual radioactivity is surface contamination and the level of removable residual radioactivity does not violate the assumptions in the model; and either

- The final concentrations result in a peak annual dose of less than 0.25 mSv (25 mrem) and the licensee has committed to calculating the annual dose using a screening analysis at license termination; or

- The planned DCGLs are equal to or less than those provided by the screening criteria, and the licensee has committed to maintaining the sum of fractions, if applicable.

Sample Evaluation Findings

The staff has reviewed the dose modeling analyses for [identifier/name of decommissioning option] as part of the review of the [name of licensee/facility]'s decommissioning plan, using Standard Review Plan 5.1.1.

The staff concludes that the dose estimate calculated using the default screening analysis is appropriate for the decommissioning option and exposure scenario assumed. In addition, this dose estimate provides reasonable assurance that the dose criterion in 10 CFR 20.1402 will be met. This conclusion is based on the modeling effort performed by the staff in initially developing the default screening analysis.

In determining the dose to the average member of the critical group, the licensee has used the assumptions inherent in the screening analysis and the parameter uncertainties have been previously evaluated on a generic basis by the staff as part of establishing the default screening analysis.

SUGGESTED FORMAT

1. Physical specifications: See Appendix B.
2. One to two paragraphs summarizing each of the items outlined in "Acceptance Criteria," above.

5.1.2 UNRESTRICTED RELEASE USING SCREENING CRITERIA FOR SURFACE SOIL RESIDUAL RADIOACTIVITY

RESPONSIBILITY FOR REVIEW

Primary NMSS: Division of Waste Management - Decommissioning Branch

Division of Fuel Cycle Safety and Safeguards - Licensing Branch

Region I: Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch

Region II: Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1

Region III: Division of Nuclear Materials Safety - Decommissioning Branch

Region IV: Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch

Secondary: None.

Support: None.

AREAS OF REVIEW

The staff will review the information provided in the decommissioning plan pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process. The findings and conclusions of the review under this SRP will be used to evaluate the decommissioning plan's compliance with 10 CFR 20.1402. The staff will review the information provided in the application on the dose assessment of the residual radioactivity remaining in surface soil (i.e., residual radioactivity at a depth of less than 30 cm) submitted by the licensee. The staff will review the assumptions regarding the source term for the residual radioactivity, and the applicability of the default residential scenario. The staff will also verify that the default parameters (DandD Version 1) or parameter ranges (DandD Version 2) were used. For decommissioning alternatives using the default screening criteria, the staff should ensure that source term information, including nuclides of interest, configuration of source, and source spatial variability, and output reports from the DandD code (if calculations were performed in lieu of using look-up tables) or calculations of the sum of fractions, if necessary, are included in the decommissioning plan.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review information pertaining to the dose modeling of surface soil without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature and the staff will review the information provided by the licensee to ensure that the licensee used the default screening analyses or published tables, appropriately. The staff will also verify that the licensee provided enough information to allow an evaluation of the appropriateness of using this approach and any assumptions used in characterizing the source term. Proper use of the screening approach will provide reasonable assurance that the decommissioning option will comply with regulations.

CALCULATION OF RADIOLOGICAL IMPACTS ON INDIVIDUALS

The overall objective of the staff review is to determine if the screening criteria were used correctly by the licensee or responsible party and whether the calculations provide reasonable assurance that potential doses would not exceed the dose limits. Specific impacts to be calculated include those associated with exposures using the default residential farmer scenario and model.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1402.

Regulatory Guidance

- Appendix C of this SRP.
- NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination."
- Draft NUREG/CR-5512, Volume 3, "Residual Radioactive Contamination From Decommissioning: Parameter Analysis."

Information to be Submitted

The staff should organize this review by first looking at the overall scope of the dose modeling contained in the decommissioning plan (possibly for several decommissioning options and/or critical groups). This scoping review, discussed in SRP 5.0, will help the reviewers identify which SRP sections are applicable for a given decommissioning plan. After the scoping review, the staff will review each of the scenarios that the licensee is using to show compliance with the regulations.

The licensee's dose modeling for surface soil should include the following items:

- Justification on the appropriateness of using the screening approach (for both the source term and the environment) at the site; and,

- A summary of the screening method (i.e., running DandD or using the look-up tables) used in the decommissioning plan.

EVALUATION FINDINGS

Evaluation Criteria

When licensees use the default screening methods and parameters inherent in the DandD code by either running the computer code or using look-up tables, the review and acceptance of nearly all areas of the analysis have already been done by NRC staff in developing the screening tool and reviewers will only need to review the source term assumptions and the overall applicability of using the screening method with the associated residual radioactivity.

The staff will determine the acceptability of the licensee's projections of: (1) radiological impacts on future individuals from residual radioactivity; and (2) compliance with regulatory criteria. The information in the decommissioning plan may be considered acceptable if it is sufficient to ensure a reasonable assessment of the possible future impacts from the residual radioactivity in surface soil. The information must allow an independent staff evaluation of the justification and assumptions.

The staff will review the following information, as necessary, for each dose assessment of residual radioactivity on surface soil that the licensee has submitted in the various decommissioning options. If the licensee did not directly calculate the dose from residual radioactivity, but instead either derived, or proposes to use, unit concentration values, the staff needs only to review the configuration of the residual radioactivity and the appropriate screening criteria section, below. Review of the spatial variability will be performed as part of the final survey. For additional review guidance, the staff is directed to the SRP's Appendix C, Section 2.

- Source Term Configuration

  The staff will confirm that the actual measurements, facility history, and planned remedial action(s) support the source term configuration used in the modeling by reviewing the information in the facility history, radiological status, and planned remedial action(s) portions of the decommissioning plan. The reviewer will review both the areal extent of contamination and the depth of penetration of the residual radioactivity into the soil. The reviewer will determine if the physical configuration of the residual radioactivity can adequately be assumed to be a layer of surface soil containing residual radioactivity without overlying surface layers. If the residual radioactivity is not limited to the upper layer of soil, then use of the default screening criteria are not warranted without addition justification, and the reviewer should evaluate the modeling using SRP Chapter 5.2.

- Residual Radioactivity Spatial Variability

  The staff will review the information provided by the licensee for conditions both before and those projected after the decommissioning alternative is complete. Based on this information, the staff will determine whether it is appropriate to make an assumption of homogeneity: (1) for the entire affected area; or (2) for major subsections of the site. The staff will then review the adequacy of the licensee's determination of a representative value (or range of values) for the residual radioactivity concentration in the source term model. At the time of the final survey, as a general guideline, staff could use the concepts related to area factors included in the MARSSIM.

- Conceptual Models

  Detailed staff review of the information is not necessary as these topics were previously addressed by staff establishing the default screening methods. The staff will verify that the site and DandD's conceptual models are compatible. Situations that would not allow the use of the DandD code as a screening tool for environmental concentrations of radionuclides would include those where the source is not predominately present in the surface soil, residual radioactivity in the aquifer, or sites with infiltration rates higher than the vertical saturated hydraulic conductivity (i.e., resulting in surface run-off or a bath-tub effect) without additional justification showing that the results would still calculate a conservative dose estimate.

- Execution of DandD Computer Code for Dose Calculations

  If the licensee has used the DandD computer code, the staff will verify that:

  – The residual radioactivity is limited to surface soil contamination;

  – The total dose calculated includes all sources of residual radioactivity;

  – The output reports verify that no parameters (other than source term concentrations) were modified; and
  – The licensee has used the 90 percentile of the dose distribution to compare with the dose limit.

- DCGLs From the DandD Code or Look-up Tables

  The licensee may use either the DandD computer code or the published look-up table (see Appendix C, Section 2) to establish nuclide-specific DCGLs equivalent to 0.25 mSv/y (25 mrem/y). If the licensee is proposing to use radionuclide-specific DCGLs, the staff will verify that:

– the residual radioactivity (for the action under review) is limited to surface soil contamination.

– if more than one radionuclide is involved, there is reasonable assurance that the sum of fractions[5] will be maintained.

If the licensee has used the DandD Version 2 computer code to calculate the radionuclide-specific DCGLs, the staff will also verify that:

– The output reports verify that no parameters (other than entering unit concentrations) were modified; and

– The licensee has used the 90 percentile of the dose distribution to derive the concentrations.

[5] Determine for each radionuclide the ratio between the concentration present and the respective DCGL. The sum of the ratios for all the radionuclides may not exceed “1" (i.e., unity). For example, if radionuclides “A,” and “B” are present at respective concentrations of “Conc A” and “Conc B,” and if the respective applicable DCGLs are “Limit A,” and “Limit B,” then the concentration shall be limited so that the following relationship exists:

$$\frac{Conc\ A}{Limit\ A} + \frac{Conc\ B}{Limit\ B} \leq 1$$

- Compliance with Regulatory Criteria

  The licensee's projections of compliance with regulatory criteria, if that decommissioning option is pursued, are acceptable provided that the staff has reasonable assurance that:

  – The licensee has applied an appropriate source term;

  – The only residual radioactivity is surface soil contamination; and either,

  – The final concentrations result in a peak annual dose of less than 0.25 mSv (25 mrem) and the licensee has committed to calculating the annual dose using a screening analysis at license termination; or

  – The planned DCGLs are equal to or less than those provided by the screening criteria, and the licensee has committed to maintaining the sum of fractions, if applicable.

<u>Sample Evaluation Findings</u>

The staff has reviewed the dose modeling analyses for [identifier/name of decommissioning option] as part of the review of the [name of licensee/facility]'s decommissioning plan, using Standard Review Plan 5.1.2.

The staff concludes that the dose estimate calculated using the default screening analysis is appropriate for the decommissioning option and exposure scenario assumed. In addition, this dose estimate provides reasonable assurance that the dose criterion in 10 CFR 20.1402 will be met. This conclusion is based on the modeling effort performed by the staff in initially developing the default screening analysis.

In determining the dose to the average member of the critical group, the licensee has used the assumptions inherent in the screening analysis and the parameter uncertainties have been previously evaluated on a generic basis by the staff as part of establishing the default screening analysis.

SUGGESTED FORMAT

1. Physical specifications: See Appendix B.
2. One or two paragraphs summarizing each of the items outlined in "Acceptance Criteria," above.

5.2 UNRESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION

RESPONSIBILITY FOR REVIEW

Primary -	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Safety Branch 1, Nuclear Materials Safety Branch 2
Secondary -	None	
Support -	Division of Waste Management - Environment and Performance Assessment Branch	

AREAS OF REVIEW

The staff will review the information provided in the decommissioning plan pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process. The findings and conclusions of the review under this SRP will be used to evaluate the decommissioning plan's compliance with 10 CFR 20.1402. The staff should ensure that, at a minimum, information on the source term, exposure scenario(s), conceptual model(s), numerical analyses (e.g., hand calculations or computer models), and uncertainty have been included. The staff will review the abstraction of, and assumptions regarding, the source term, the conceptual model of the site or building, as appropriate, the exposure scenario(s), the mathematical method employed and the parameters used in the analysis, and their uncertainty.

The amount of information provided by the licensee and the depth of the reviewer's investigation of that information will depend on the complexity of the case and the number of site-specific information being used by the licensee. This SRP section has been written for review of the most complex analyses, most analyses will not need in-depth review of all parts of the evaluation criteria.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the dose modeling portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature and the staff will review the information provided by the licensee to ensure that the licensee used defensible assumptions and models to calculate the potential dose to the average member of the critical group. The staff will also verify that the licensee provided enough information to allow an independent evaluation of the potential dose resulting from the residual radioactivity after license termination and provide reasonable assurance that the decommissioning option will comply with regulations.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1402.

Regulatory Guidance

- Appendix C of this SRP.
- NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination."
- NUREG/CR-5512, Volume 1, "Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent."
- Draft NUREG/CR-5512, Volume 2, "Residual Radioactive Contamination from Decommissioning: User's Manual."
- Draft NUREG/CR-5512, Volume 3, "Residual Radioactive Contamination from Decommissioning: Parameter Analysis."
- Federal Guidance Report Number 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion."
- Federal Guidance Report Number 12, "Dose Coefficients for External Exposure to Radionuclides Distributed in Air, Water, and Soil."

Information to be Submitted

The staff should organize this review by first looking at the overall scope of the dose modeling contained in the decommissioning plan (possibly for several decommissioning options and/or critical groups). This scoping review, discussed in Section 5.0, will help the reviewers identify which SRP is applicable for a given dose assessment. After the scoping review, the staff will review each of the scenarios that the licensee is using to show compliance with the regulations.

The licensee's or responsible party's dose modeling for unrestricted release using site-specific information[6] should include the following:

- Source term information including nuclides of interest, configuration of the source, areal variability of the source, etc;
- A description of the exposure scenario including a description of the critical group;
- A description of the conceptual model of the site including the source term, physical features important to modeling the transport pathways, and the critical group;
- Identification, description and justification of the mathematical model used (e.g., hand calculations, DandD Screen v1.0, RESRAD v6.0, etc.);
- A description of the parameters used in the analysis;
- A discussion about the effect of uncertainty on the results; and
- Input and output files or printouts, if a computer program was used.

EVALUATION FINDINGS

<u>Evaluation Criteria</u>

The staff will determine the acceptability of the licensee's projections of: (1) radiological impacts on future individuals from residual radioactivity; and (2) compliance with regulatory criteria. The information in the decommissioning plan is acceptable if it is sufficient to ensure a defensible assessment of the possible future impacts from the residual radioactivity. The licensee's assessment can be as realistic (or conservative), as necessary to meet the dose limit. The information must allow an independent staff evaluation of the assumptions used (e.g., source term configuration, applicable transport pathways, etc.) and possible doses to the average

[6] "site-specific" is being used in a very general sense, as it captures any dose analysis that is done other than those using the default screening tools. This may be as simple as a few parameter changes, in the DandD computer code from their default values, to licensees using scenarios, models, and parameter ranges that are only applicable at the licensee's site.

member of the critical group.

The staff will review the following information, as necessary, for each dose assessment of residual radioactivity that the licensee (or responsible party) has submitted in the various decommissioning options. An exception is if the licensee did not directly calculate the dose from residual radioactivity, but instead either derived, or proposes to use, unit concentration values, the staff does not need to review the “Source Term’s Areal Variability” section, because that review will occur during acceptance of the final site survey.

- Source Term

  The staff will review the assumptions used by the licensee to characterize the facility’s source term of residual radioactivity for dose modeling purposes. The staff will compare the assumptions with the current site information (SRP 4.0) and the decommissioning alternative’s goal (SRP 6.0). The model should be an appropriate generalization of this information. Three key areas of review for the source term assumptions are the: (1) configuration; (2) residual radioactivity spatial variability; and (3) chemical form(s). For additional review guidance, the staff is directed to the SRP’s Appendix C, Section 3.

  - Configuration

    The staff will confirm that the actual measurements, facility history, and planned remedial action(s) support the source term configuration used in the modeling by reviewing the information in the facility history, radiological status, and planned remedial action(s) portions of the decommissioning plan.. The reviewer will review the provided information for both the areal extent of contamination and the depth (for soil or buildings) or volume (for groundwater) of the residual radioactivity. The reviewer will determine if the information provided supports the configuration assumptions used in the exposure scenario and mathematical model (e.g., a thin layer of residual radioactivity on the building surfaces).

  - Residual Radioactivity Spatial Variability

    The staff will review residual radioactivity concentration values provided by the licensee for conditions both before, and projected after, the decommissioning alternative is complete. For this subsection, the staff will review the spatial extent and the degree of heterogeneity in the values. Based on this information, the staff should determine whether it is reasonable to make an assumption of homogeneity for each source: (1) for the whole site; or (2) for subsections of the site. The staff will then review the adequacy of the licensee’s determination of a representative value (or range of values) for the residual radioactivity concentration in the source term model. At the time of final survey, as a general guideline, staff could use the concepts related to area factors included in the MARSSIM.

If the licensee has derived concentration guidelines as a result of dose modeling, instead of estimating final concentrations and then, entering them into the code, the licensee need not specifically address the spatial variability acceptance criteria at this time. The licensee will need to verify that the spatial variability is as homogenous as necessary during the final survey.

- Chemical Form

  The licensee's assumptions regarding the chemical form of the residual radioactivity will be reviewed for its adequacy by the staff. The staff must determine whether the licensee has considered possible chemical changes that may occur during the time period of interest. Without any justification of possible chemical forms, the analysis should use the bounding chemical form(s) (i.e., the chemical form(s) that give the individual the highest dose per unit intake in Federal Guidance Report Number 11). Acceptable rationale for other assumptions should be justified by the licensee. Some acceptable rationales for using other chemical forms are: (1) chemical forms that would degrade quickly in the environment (e.g., UF_6); or (2) the unavailability of an element to realistically form that molecule (e.g., $SrTiO_4$).

- Critical Groups, Scenarios, and Pathways Identification and Selection

In its review, the staff will confirm that the licensee has identified and quantified the most significant scenarios based on available site- or facility-specific information. The staff will review the basis and justification for the licensee's selected critical group. For scenarios in which possible environmental pathways have been modified or eliminated, the staff will review the justifications provided by the licensee. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 4.

- Scenario Identification

  The exposure scenario is based on the location and type of source (e.g., contaminated walls), the general characteristics and habits of the critical group (e.g., an adult light industry worker) and the possible pathways which describe how the residual radioactivity would incur dose in humans. The licensee must provide justification on the scenario(s) evaluated by the licensee.

  The default scenarios for building surface residual radioactivity and soil contamination are described in NUREG-1549 and NUREG/CR-5512, Volumes 1, 2 and 3. Dose evaluations that use these scenarios (i.e., the licensee changes parameter values or mathematical method but doesn't change the general scenario) are acceptable, if the scenario is appropriate for the situation. In decommissioning plans where the licensee eliminates certain pathways, with justification, but still maintains the same general scenario category, the staff will find the scenario identification to be acceptable. For example, a licensee may eliminate the use of groundwater because the near surface aquifer has total dissolved solids of 30,000 mg/l. The licensee still evaluates the impacts from crops grown in the residual radioactivity but irrigation is provided by a non-contaminated source and therefore, the generic scenario, a residential farmer, is maintained.

Under certain situations, the default general scenarios will not be appropriate for the site conditions. The licensee will need to provide justification for alternate scenarios. Reviewers may wish to evaluate the appropriateness of the critical group selection and the exposure pathways in these cases before deciding on the appropriateness of the overall scenario.

- Critical Group Determination

  The critical group represents a group that could receive the highest dose from the residual radioactivity. In general, critical groups that are exposed to multiple exposure pathways result in higher doses than groups with more limited interaction with the residual radioactivity. NUREG-1549 and the NUREG/CR-5512 series, details the critical group assumptions for the default scenarios. In decommissioning plans where the licensee has used the default scenarios, the reviewer should verify that the critical group is the same as listed in NUREG-1549 and the NUREG/CR-5512 series.

  For situations where the licensee has eliminated/modified certain pathways, the licensee will need to justify why the exposure group definition does not change from the default assumptions. Although not all changes in the exposure pathway will result in a new critical group, possible reasons for changing critical group assumptions include: (1) the available exposure pathways have changed from those in default scenarios; and (2) the default scenario is inappropriate based on assumptions regarding current (and informed consideration of future) land use practices in the area (e.g., a small site in a heavily urbanized area).

- Exposure Pathways

  The decommissioning plan should describe the exposure pathways[7] to which the

[7] Although originally created for analysis of low-level waste disposal, NUREG/CR-5453, Vol. 2, “Background Information for the Development of a Low-Level Waste Performance Assessment

critical group is exposed, except for cases where the licensee or responsible party is using the default scenarios and critical groups without modification. For cases where the licensee has modified or eliminated exposure pathways, the changes must be justified. In general, the justification should be based on physical limitations or situations that would not allow individuals to be exposed as described in the scenario.

For example, acceptable justifications for removing the groundwater pathway include: (1) the near surface groundwater is neither potable nor allowed to be used for irrigation; (2) aquifer volume is insufficient to provide the necessary yields; and (3) there is current (and informed consideration of future) land use patterns that would preclude groundwater use, coupled with relatively short half-life material (e.g., the peak exposures would occur within 100 years and the site is currently in an industrial section of an urban area). Justification of water quality and quantity of the saturated zone should be based on the classification systems used by the U.S. Environmental Protection Agency or the State, as appropriate. For cases where the aquifer is classified as not being a source of drinking water but is adequate for stock watering and irrigation, the licensee can eliminate (does not need to consider) the drinking water pathway (and generally, the fish pathway, depending on the model) but should still maintain the irrigation and meat/milk pathways.

Another example would be a site with a relatively small discrete outdoor area of residual radioactivity (compared to the area assumed in the default scenarios). In this situation, it may be appropriate, based on the area of residual radioactivity, that gardening of some vegetables and fruits would still be an assumption but the area is not large enough to allow one to grow grain, or raise animals for meat or milk.

- Conceptual Models

  The staff will review the adequacy of the conceptual model used by the licensee. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 5.

  The conceptual model should qualitatively describe the following:

  – The relative location and activities of the critical group;
  – Both the hydrologic and environmental transport processes important at the site;
  – The dimensions, location and spatial variability of the source term used in the model; and

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Methodology: Assessment of Relative Significance of Migration and Exposure Pathways" (Sandia National Laboratories, 1991) contains an extensive listing of possible exposure pathways to be assessed.

– Major assumptions made by the licensee in developing the conceptual model (e.g., recharge of the aquifer is limited to the infiltration through the site's footprint).

The reviewer must verify that the site conditions discussed in SRP Modules 2.0 and 3.0 are adequately addressed in the conceptual model and simplifying assumptions.

- Calculations and Input Parameters

In its review, the staff will confirm that the licensee has used a mathematical model that is an adequate representation of the conceptual model and the exposure scenario. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Sections 6 and 7.

○ Execution of DandD Computer Code

If the licensee has used the DandD computer code in its analysis, the staff will verify the following points:

– The residual radioactivity is limited to surface contamination (either building or near surface soil, as appropriate);

– The site conceptual model is adequately represented by DandD's inherent conceptual model;

– For building surfaces, if the total dose is greater than 10 percent of the dose limit, the licensee has modified the resuspension fraction to account for the removable fraction to be present at the time of decommissioning;

– For sites eliminating pathways, the licensee has used the appropriate parameters in the DandD code as "switches" to turn off the pathways without unintentionally removing others. For example, to remove the groundwater pathways, the licensee must set the drinking water rate, irrigation rate, and pond volume to 0;

– For each parameter modified, the licensee has adequately justified the new parameter value or range and has evaluated the effect on other parameters.

– For modifications of behavioral parameters, the changes must be based on acceptable changes in the critical group, and the mean value of the behavior should be used, although use of the range is also acceptable; and

– If the licensee has randomly sampled the parameter ranges in DandD, the licensee has used the peak of the mean dose distribution to either calculate the dose or derive the DCGLs.

- Other Mathematical Methods

  The staff will verify:

  - The mathematical method's conceptual model is compatible with the site's conceptual model (e.g., RESRAD v. 6.0 would not be an acceptable mathematical method for sites with building surface contamination);

  - For each parameter or parameter set, the licensee has adequately justified the parameter value or range. For modifications of behavioral parameters, the changes must be based on acceptable changes in the critical group, and the mean value (or full range) of the behavior should be used; and

  - For residual radioactivity resulting in alpha decay (e.g., uranium or thorium) and present on building surfaces, the staff will review the resuspension factor/rate and the assumptions regarding the degree of removable residual radioactivity. For example, if the licensee has assumed that 10 percent of the residual radioactivity will be removable at the time of unrestricted release, the model's parameters should either implicitly or explicitly include this assumption (see draft NUREG/CR-5512, Volume 3, on how it has been done for the DandD code).

  - If the licensee has randomly sampled the parameter ranges, the licensee has used the peak of the mean dose distribution to either calculate the dose or derive the DCGLs.

- Uncertainty Analysis

  The staff will review the licensee's discussion of the uncertainty resulting from the physical parameter values used in the analysis. The review should focus on the uncertainty analysis for the critical pathways or parameters. Reviewers should expect that the degree of uncertainty analysis will depend on the level of complexity of the modeling (e.g., generally qualitative discussions for simple modeling to quantitative for more complex sites). The overall acceptability of the uncertainty analysis will be evaluated on a case by case basis. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 8.

- Compliance with Regulatory Criteria

The licensee's projections of compliance with regulatory criteria are acceptable provided that the staff has reasonable assurance that:

- The licensee has adequately characterized and applied its source term;

- The licensee has analyzed the appropriate scenario(s) and that the exposure group(s) adequately represents a critical group;

- The mathematical method and parameters used are appropriate for the scenario and parameter uncertainty has been adequately addressed;

- For deterministic analyses, the peak annual dose to the average member of the critical group for the appropriate exposure scenario(s) for the option is less than (or equal to) 0.25 mSv (25 mrem), or was used to calculate DCGLs;

- For probabilistic analyses, the peak of the mean dose distribution to the average member of the critical group for the appropriate exposure scenario(s) for the option is less than (or equal to) 0.25 mSv (25 mrem), or was used to calculate DCGLs; and either

- The licensee has committed to either using a specific scenario, model and set of parameters with the final survey results to show final compliance with the dose limit; or

- The licensee has committed to radionuclide-specific DCGLs and will ensure that the sum of fractions is met for all radionuclides.

<u>Sample Evaluation Findings</u>

The staff has reviewed the dose modeling analyses for [identifier/name of decommissioning option] as part of the review of the [name of licensee/facility]'s decommissioning plan using Standard Review Plan 5.2.

The staff concludes that the dose modeling completed for [option description] is reasonable and is appropriate for the exposure scenario under consideration. In addition, the dose estimate provides reasonable assurance that the dose to the average member of the critical group is not likely to exceed the 0.25 mSv (25 mrem) annual dose criterion in 10 CFR 20.1402. This conclusion is based on the modeling effort performed by the licensee and the independent analysis performed by the staff.

In determining the dose, the licensee has a combination of the conceptual model, exposure scenario, mathematical model and input parameters to calculate a reasonable estimate of dose. The licensee has adequately considered the uncertainties inherent in the modeling analysis.

[The Safety Evaluation Report also should include: (1) a brief summary of any independent analyses conducted by the staff; (2) reference to the mathematical method(s) used; and (3) a comparison of the value(s) computed by the staff with those of the licensee.]

SUGGESTED FORMAT

1. Physical specifications: See Appendix B.

2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above, with appendices as necessary.

5.3 RESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION

RESPONSIBILITY FOR REVIEW

Primary -	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Safety Branch 1, Nuclear Materials Safety Branch 2
Secondary -	None.	
Support -	Division of Waste Management - Environmental and Performance Assessment Branch	

AREAS OF REVIEW

The staff will review the information provided in the decommissioning plan pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process. The findings and conclusions of the review under this SRP will be used to evaluate the decommissioning plan's compliance with 10 CFR 20.1403. The staff should ensure that, at a minimum, information on the source term, exposure scenario(s), conceptual model(s), numerical analyses, and uncertainty have been included. A minimum of two scenarios will need to be submitted by the licensee: one where the restrictions are working [10 CFR §20.1403(b)]; and one where the restrictions have failed [10 CFR §20.1403(e)]. The staff will review the abstraction of, and assumptions regarding, the source term; the conceptual model of the site, or building, as appropriate; the exposure scenarios, including the effects of the proposed restrictions; the mathematical method employed and the parameters used in the analyses; and their uncertainty.

The amount of information provided by the licensee and the depth of the reviewer's investigation of that information will depend on the complexity of the case and the amount of site-specific information being used by the licensee. This SRP section has been written for review of the most complex analyses. Most analyses will not need in-depth review of all parts of the evaluation criteria.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the dose modeling portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature and the staff will review the information provided by the licensee to ensure that the licensee used defensible assumptions and models to calculate the potential dose to the average member of the critical group. The staff will also verify that the licensee provided enough information to allow an independent evaluation of the potential dose resulting from the residual radioactivity after license termination and provide reasonable assurance that the decommissioning option, selected by the licensee or responsible party, will comply with NRC's regulations.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1403(b)(1)(i)(A).
10 CFR 20.1403(e).

Regulatory Guidance

- Appendix C of this SRP.
- NUREG-1200, "SRP for the review of a license application for a Low-Level Radioactive Waste Disposal Facility" (sic), Chapter 6.
- NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination."
- NUREG/CR-5512, Volume 1, "Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent."
- Draft NUREG/CR-5512, Volume 2, "Residual Radioactive Contamination from Decommissioning: User's Manual."
- Draft NUREG/CR-5512, Volume 3, "Residual Radioactive Contamination from Decommissioning: Parameter Analysis."
- Federal Guidance Report Number 11, "Limiting Values of Radionuclide Intake and Air

Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion."

- Federal Guidance Report Number 12, "Dose Coefficients for External Exposure to Radionuclides Distributed in Air, Water, and Soil."
- Division of Waste Management "Technical Position on a Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities."

Information to be Submitted

The staff should organize this review by first reviewing the overall scope of the dose modeling in the decommissioning plan (possibly for several decommissioning options or scenarios). This scoping review, discussed in Section 5.0 above, will help the reviewers identify which dose modeling SRP section is applicable for a given dose assessment. After the scoping review, the staff will review each of the scenarios that the licensee is using to show compliance with the regulations.

The licensee's or responsible party's dose modeling for restricted release using site-specific information[8] should include the following information. The licensee or responsible party may need to address each item separately for the two compliance calculations (i.e., with restrictions in place and if restrictions fail).

- Source term information including nuclides of interest, configuration of the source, areal variability of the source, and chemical forms;
- A description of the exposure scenarios including a description of the critical group for each scenario and the effect of site restrictions, if any;
- A description of the conceptual model(s) of the site that includes the source term, physical features important to modeling the transport pathways, and the critical group for each scenario;
- Identification/description of the mathematical model(s) used (e.g., hand calculations, RESRAD v6.0, etc.);
- A summary of parameters used in the analysis;
- A discussion about the effect of uncertainty on the results; and
- Input and output files or printouts, if a computer program was used.

EVALUATION FINDINGS

[8] "site-specific" is being used in a very general sense, as it captures any dose analysis that is done other than those using the default screening tools. This may be as simple as a few parameter changes, in the DandD computer code from their default values, to licensees using scenarios, models, and parameter ranges that are only applicable at the licensee's site.

Evaluation Criteria

The staff will determine the acceptability of the licensee's projections of: (1) radiological impacts on future individuals from residual radioactivity; and (2) compliance with regulatory criteria. The information in the decommissioning plan is acceptable if it is sufficient to ensure a defensible assessment of the potential doses from the residual radioactivity. The licensee's assessment, which needs to be based on justifiable bases, assumptions and parameters, can be as realistic (or conservative) as necessary to meet the dose limit. The information must allow an independent staff evaluation of the assumptions used (e.g., source term configuration, applicable transport pathways, etc.) and possible doses to the average member of the critical group.

The staff will review the following information, as necessary, for each dose assessment from residual radioactivity that the licensee (or responsible party) has submitted in the various decommissioning options.

- Source Term

  The staff will review the assumptions used by the licensee to characterize the facility's source term of residual radioactivity for dose modeling purposes. The staff will compare the assumptions with the current site information (SRP 4.0) and the decommissioning alternative's goal (SRP 6.0). The model should be an appropriate generalization of this information. Three key areas of review for the source term assumptions are the: (1) configuration; (2) residual radioactivity spatial variability; and (3) chemical form(s). For additional review guidance, the staff is directed to the SRP's Appendix C, Section 3.

  - Configuration

    The staff will confirm that the actual measurements, facility history, and planned remedial action(s) support the source term configuration used in the modeling by reviewing the information in the facility history, radiological status, and planned remedial action(s) portions of the decommissioning plan. Staff will review the information for both the areal extent of contamination and the depth (for soil or buildings) or volume (for groundwater) of the residual radioactivity. Staff will determine if the information provided supports the configuration assumptions used in the exposure scenario and mathematical model (e.g., a thin layer of residual radioactivity on the building surfaces).

  - Residual Radioactivity Spatial Variability

    The staff will review residual radioactivity concentration values provided by the licensee for conditions both before, and projected after, the decommissioning is complete. For this subsection, the staff will review the spatial extent and the degree of heterogeneity in the values. Based on this information, the staff should determine whether it is reasonable to make an assumption of homogeneity for each source: (1) for the whole facility (or site); or (2) for subsections of the facility (or site). The staff will then review the adequacy of the licensee's determination of a representative value (or range of values) for the residual radioactivity concentration in the source term model. At the time of final survey, as a general guideline, staff could use the concepts related to area factors included in the MARSSIM.

If the licensee has derived concentration guidelines as a result of dose modeling, instead of estimating final concentrations and then, entering them into the code, the licensee need not specifically address the spatial variability acceptance criteria at this time. The staff will need to verify that the spatial variability is as homogenous as necessary during the final survey.

- ○ Chemical Form

  The licensee's assumptions regarding the chemical form of the residual radioactivity will be reviewed for adequacy. The staff must determine whether the licensee has considered possible chemical changes that may occur during the time period of interest. Without any justification of possible chemical forms, the analysis should use the bounding chemical form(s) (i.e., the chemical form(s) that give the individual the highest dose per unit intake in Federal Guidance Report Number 11). Acceptable rationales for other assumptions should be justified by the licensee. Some acceptable rationales for using other chemical forms are: (1) chemical forms that would degrade quickly in the environment (e.g., UF_6); or (2) the unavailability of an element to realistically form that molecule (e.g., $SrTiO_4$).

- Critical Groups, Scenarios, and Pathways Identification and Selection

  In its review, the staff will confirm that the licensee has identified and quantified the most significant scenarios based on available site- or facility-specific information including proposed site restrictions. A minimum of two scenarios will be necessary to evaluate both dose limits. One addresses the situation when the restrictions are in place and working properly. The other addresses the possible doses that may occur if restrictions were to fail or only partially work. The staff will review the basis and justification for the licensee's selected critical group for each scenario. For scenarios in which possible environmental pathways have been modified or eliminated, the staff will review the justifications provided by the licensee for those modifications or eliminations. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 4.

  - ○ Scenario Identification

    The exposure scenario is based on the location and type of source (e.g., contaminated walls), the general characteristics and habits of the critical group (e.g., an adult light-industry worker); and the possible pathways which describe how the residual radioactivity could incur potential doses in humans. The licensee must provide justification for why each scenario was selected.

The default scenarios for building surface residual radioactivity and soil contamination are described in NUREG-1549 and the NUREG/CR-5512 series. The scenarios were developed for situations involving unrestricted release. Dose evaluations that use these scenarios (i.e., the licensee changes parameter values or mathematical method but doesn't change the general scenario) are acceptable, if the scenario is appropriate for the situation. In decommissioning plans where the licensee eliminates certain pathways, with justification, but still maintains the same general scenario category, the staff will find the scenario identification to be acceptable. For example, a licensee may eliminate the use of groundwater because the near-surface aquifer has total dissolved solids of 30,000 mg/l. The licensee still evaluates the impacts from crops grown in the residual radioactivity but irrigation is provided by a non-contaminated source, and therefore, the generic scenario, a residential farmer, is maintained.

Under most scenarios involving the successful use of site restrictions, the default general scenarios will not necessarily be appropriate for the site conditions. The licensee will need to provide justification for alternate scenarios. Reviewers may wish to evaluate the appropriateness of the critical group selection and the exposure pathways in these cases before deciding on the appropriateness of the overall scenario.

The restrictions at a site may result in the evaluation of an off-site exposure scenario. Staff is directed to Chapter 6 of NUREG-1200 and the DWM "Technical Position on a Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities" for additional guidance focused on assessing off-site exposure.

○ Critical Group Determination

The critical group represents a group that could receive the highest dose from the residual radioactivity. In general, critical groups that are exposed to multiple exposure pathways result in higher doses than groups with more limited interaction with the residual radioactivity. NUREG-1549 and the NUREG/CR-5512 series details the critical group assumptions for the default scenarios. In instances where the licensee has used the default scenarios, staff should verify that the critical group is the same as that listed in NUREG-1549 and the NUREG/CR-5512 series. In other cases, the default scenarios should be used

as a guide to review the proposed critical group. For example, it may be acceptable to use the default critical group for contaminated surface soil in off-site exposure scenarios (i.e., a resident farmer using contaminated groundwater flowing from the site).

For situations where the licensee has eliminated/modified certain pathways, the licensee will need to justify why the exposure group definition has or has not changed from the default assumptions. Although not all changes in the exposure pathway will result in a new critical group, possible reasons for changing critical group assumptions include: (1) the available exposure pathways have changed from those in default scenarios resulting in a new critical pathway; (2) the default scenario is inappropriate based on assumptions regarding current (and informed consideration of future) land use practices in the area (e.g., a small site in a heavily urbanized area); or (3) proposed restrictions.

- Exposure Pathways

The decommissioning plan should describe the exposure pathways[9] to which the critical group is expected to be exposed, except for cases where the licensee or responsible party is using the default scenarios and critical groups without modification. For cases where the licensee has modified or eliminated exposure pathways, the changes must be justified. In general, the justification should be based on physical limitations or situations that would not allow individuals to be exposed as described in the scenario. The licensee may also use proposed restrictions to eliminate or change exposure pathways.

For example, acceptable justifications for removing the groundwater pathway based on physical limitations include: (1) the near surface groundwater is neither potable nor allowed to be used for irrigation; (2) aquifer volume is insufficient to provide the necessary yields; (3) there is current (and informed consideration of future) land use patterns that would preclude groundwater use coupled with relatively short half-life material (e.g., the peak exposures would occur within 100 years and the site is currently in an industrial section of an urban area); or (4) site restrictions would preclude groundwater use. Justification of water quality and quantity of the saturated zone should be based on the classification systems used by the U.S. Environmental Protection Agency or the State, as appropriate.

For cases where the aquifer is classified as not being a source of drinking water but is adequate for stock watering and irrigation, the licensee can eliminate the

[9] While originally created for analysis of low-level waste disposal, NUREG/CR-5453 Vol. 2 "Background Information for the Development of a Low-Level Waste Performance Assessment Methodology: Assessment of Relative Significance of Migration and Exposure Pathways" (Sandia National Laboratories, 1991) contains an extensive listing of possible exposure pathways to be assessed.

drinking water pathway (and generally, the fish pathway, depending on the model) but should still maintain the irrigation and meat/milk pathways.

Another example would be a site with a relatively small, discrete, outdoor area of residual radioactivity (compared with the area assumed in the default scenarios). In this situation, it may be appropriate, based on the area of residual

radioactivity, that gardening of some vegetables and fruits would still be an assumption, but the area is not large enough to allow one to grow grain, or raise animals for meat or milk.

- Conceptual Models

  The staff will review the adequacy of the conceptual model(s) used by the licensee for each exposure scenario, as appropriate. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 5.

  The conceptual model needs to qualitatively describe the following:

  - The relative location and activities of the critical group;
  - Both the hydrologic and environmental transport processes important at the site;
  - The dimensions, location and spatial variability of the source term used in the model; and
  - Major assumptions made by the licensee in developing the conceptual model (e.g., recharge of the aquifer is limited to the infiltration through the site's footprint).
  - The effects of the site restrictions on transport or exposure pathways.

  The reviewer must verify that the site conditions discussed in SRP Modules 2.0, 3.0, and 16 are adequately addressed in the conceptual model and simplifying assumptions.

- Calculations and Input Parameters

  In its review, the staff will confirm that the licensee has used a mathematical model that is an adequate representation of the respective conceptual model and exposure scenario. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 6 and 7. For off-site exposure scenarios, the staff is directed to Chapter 6 of NUREG-1200 for additional guidance on specific aspects of the modeling.

  - Execution of DandD Computer Code

    If the licensee has used the DandD computer code in its set of analyses, the staff will evaluate the following criteria:

- The residual radioactivity is limited to surface contamination (either building or near surface soil, as appropriate);

- The site conceptual model is adequately represented by DandD's inherent conceptual model;
- For building surfaces, if the total dose is greater than 10 percent of the dose limit, the licensee has modified the resuspension fraction to account for the removable fraction to be present at the time of decommissioning;

- For sites eliminating pathways, the licensee has used the appropriate parameters in the DandD code as "switches" to turn off the pathways without unintentionally removing others. For example, to remove the groundwater pathways, the licensee must set the drinking water rate, irrigation rate, and pond volume to 0;

- For each parameter modified, the licensee has adequately justified the new parameter value or range and has considered the effects on other parameters. For modifications of behavioral parameters, the changes must be based on acceptable changes in the critical group, and the mean value of the behavior should be used, though use of the range is also acceptable; and

- If the licensee has randomly sampled the parameter ranges in DandD, the licensee has used the peak of the mean annual dose distribution to either compare with the dose limit, or calculate DCGLs.

○ Other Mathematical Methods

The staff will verify that:

- The mathematical method's conceptual model is compatible with the site's conceptual model (e.g., RESRAD v. 6.0 would not be an acceptable mathematical method for sites with building surface contamination);

- For each parameter or parameter set, the licensee has adequately justified the new parameter value or range and has considered the effects on other parameters. For modifications of behavioral parameters, the changes must be based on acceptable changes in the critical group, and the mean value (or full range) of the behavior should be used; and

- For residual radioactivity resulting in alpha decay (e.g., uranium or thorium) and present on building surfaces, the staff will review the resuspension factor/rate and the assumptions regarding the percent of removable residual radioactivity. For example, if the licensee has assumed that 10 percent of the residual radioactivity will be removable at license termination, the model's parameters should either implicitly or explicitly include this assumption (see draft NUREG/CR-5512, Volume 3 on how it has been done for the DandD code).

– If the licensee has randomly sampled the parameter ranges, the licensee has used the peak of the mean dose distribution to either calculate the dose or derive the DCGLs.

- Uncertainty Analysis

  The staff will review the licensee's discussion of the uncertainty resulting from the physical parameter values used in the analysis. The review should focus on the uncertainty analysis for the critical pathways or parameters. Reviewers should expect that the degree of uncertainty analysis will depend on the level of complexity of the modeling (e.g., generally qualitative discussions for simple modeling to quantitative for more complex sites). The overall acceptability of the uncertainty analysis will be evaluated on a case-by-case basis. For additional guidance on these subjects, the staff is directed to the SRP's Appendix C, Section 8.

- Compliance with Regulatory Criteria [10 CFR §20.1403(b) & §20.1403(e)]

The licensee's projections of compliance with regulatory criteria are acceptable provided that the staff has reasonable assurance that the following criteria are met:

- The licensee has adequately characterized and applied its source term;
- The licensee has analyzed the appropriate scenario(s) and that the exposure group(s) adequately represents a critical group;
- The mathematical method(s) and parameters used are appropriate for the scenarios and parameter uncertainty has been adequately addressed;
- For deterministic analyses, the peak annual dose to the average member of the critical group is in compliance with the 10 CFR 20.1403(b) or 20.1403(e) dose criteria, as appropriate;
- For probabilistic analyses, the peak of the mean dose distribution to the average member of the critical group for the appropriate exposure scenario(s) for the option is in compliance with the 10 CFR 20.1403(b) or 20.1403(e) dose criteria, as appropriate, or was used to calculate the limiting DCGLs; and either

  – The licensee has committed to either using a specific scenario, model and set of parameters with the final survey results to show final compliance with the dose limits; or

- The licensee has committed to radionuclide-specific DCGLs and will ensure that the sum of fractions is met for all radionuclides.

Sample Evaluation Findings

The staff has reviewed the dose modeling analyses for [identifier/name of decommissioning option] as part of the review of the [name of licensee/facility]'s decommissioning plan using Standard Review Plan 5.3.

The staff concludes that the dose modeling completed for [option description] is reasonable and is appropriate for the exposure scenarios under consideration. The dose estimates provide reasonable assurance that if the restrictions work as proposed, the dose to the average member of the critical group is not likely to exceed the 0.25-mSv (25-mrem) annual dose limit in 10 CFR 20.1403(b), and if they fail, the dose to the average member of the critical group is not likely to exceed the annual dose limit in 10 CFR 20.1403(e). This conclusion is based on the modeling effort performed by the licensee and the independent analyses and review performed by the staff.

In determining the dose, the licensee has used a combination of the conceptual model(s), exposure scenarios, mathematical model(s), and input parameters to calculate a reasonable estimate of dose. The licensee has adequately considered the uncertainties inherent in the modeling analysis.

[The staff's technical evaluation report should include: (1) a brief summary of the exposure scenarios used to evaluate compliance with 10 CFR 20.1403; (2) a brief summary of any independent analyses conducted by the staff; (3) reference to the mathematical method(s) used; and (4) a comparison of the dose value(s) computed by the staff with those of the licensee.]

SUGGESTED FORMAT

1. Physical specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in "Acceptance Criteria," above, with appendices as necessary.

5.4 RELEASE INVOLVING ALTERNATE CRITERIA

RESPONSIBILITY FOR REVIEW

Primary -	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Safety Branch 1, Nuclear Materials Safety Branch 2
Secondary -	None.	
Support -	Division of Waste Management - Environmental and Performance Assessment Branch	

AREAS OF REVIEW

The staff will review the information provided in the decommissioning plan pertaining to the licensee's proposed alternate criteria. The findings and conclusions of the review under this SRP will be used to evaluate the decommissioning plan's compliance with 10 CFR 20.1404. The staff should ensure that, at a minimum, information on the source term, exposure scenario(s), conceptual model(s), numerical analyses, and uncertainty have been included, if appropriate. The staff will review the abstraction of, and assumptions regarding, the source term; the conceptual model of the site or building, as appropriate; the exposure scenarios; the mathematical method employed and the parameters used in the analyses; and their uncertainty. The staff will also review the health and safety (or protection of the environment) basis for the alternate criteria proposed.

The amount of information provided by the licensee and the extent of the staff's review of that information will depend on the complexity of the case and the amount of site-specific information being used by the licensee.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under “Areas of Review,” above. Staff will review the dose modeling portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under “Areas of Review,” above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

In addition, an alternative release proposal under 10 CFR 20.1404 may allow a dose of up to 1 mSv/y (100 mrem/y) with restrictions in place. However, if the restrictions fail the dose may not exceed the values in 10 CFR 20.1403(e). Furthermore, the provisions of 10 CFR 20.1403 must be met with the exception that the reference to 0.25 mSv/y (25 mrem/y) may be replaced with a dose level up to 1 mSv/y (100 mrem/y), if justified.

Safety Evaluation

The material to be reviewed is technical in nature and the staff will review the information provided by the licensee to ensure that the licensee used defensible assumptions and models to establish and demonstrate compliance with the proposed alternate criteria. The staff will also verify that the licensee provided enough information to allow an independent evaluation of the assessment resulting from the residual radioactivity after license termination and provide reasonable assurance that the decommissioning option will comply with regulations. Each evaluation will be performed on a case-by-case basis. The staff should use the “Acceptance Criteria” in Section 5.3 of this SRP and Chapter 6 of NUREG-1200 as guidelines in developing site-specific acceptance criteria for the proposed alternate criteria and the licensee’s compliance evaluation.

SUGGESTED FORMAT

1 Physical specifications: See Appendix B.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 6.0
ALTERNATIVES CONSIDERED AND RATIONALE FOR CHOSEN ALTERNATIVE

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	Office of General Counsel	

MOST OF INFORMATION DISCUSSED IN THIS SECTION OF THE SRP APPLIES TO LICENSEES APPLYING FOR LICENSE TERMINATION UNDER 10 CFR 20.1403 (RESTRICTED USE) OR 10 CFR 20.1404 (ALTERNATE CRITERIA). LICENSEES APPLYING FOR LICENSE TERMINATION PURSUANT TO 10 CFR 20.1402 (UNRESTRICTED USE) DO NOT NEED TO SUPPLY ALL OF THE INFORMATION DISCUSSED BELOW. HOWEVER, AT A MINIMUM, THEY WOULD BE REQUIRED TO PROVIDE A SUMMARY OF THEIR EVALUATION OF NOT CONDUCTING ANY DECOMMISSIONING OPERATIONS (I.E., THE "NO ACTION" ALTERNATIVE). IN ADDITION, LICENSEES REQUESTING LICENSE TERMINATION PURSUANT TO 10 CFR 20.1403 OR 10 CFR 20.1404 MAY INCLUDE THE INFORMATION IN AN ENVIRONMENTAL REPORT OR THE DECOMMISSIONING PLAN.

AREAS OF REVIEW.

The staff will review the information supplied by the licensee or responsible party to determine if the licensee has identified and adequately evaluated all reasonable alternatives that could accomplish the decommissioning objective(s) identified in the decommissioning plan. Information submitted should include descriptions of all reasonable decommissioning alternatives evaluated by the licensee; the impacts of each alternative; the environmental, economic, and or societal advantages and disadvantages of each alternative; and, the licensee's rationale for selecting the preferred alternative described in the decommissioning plan.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the evaluation of decommissioning alternatives in the decommissioning plan without assessing the technical accuracy or completeness of the information. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will verify that the licensee has identified all reasonable alternatives that could accomplish the decommissioning objective(s), including the environmentally preferable alternative. The staff will make a qualitative assessment as to whether the licensee's or responsible party's descriptions of the alternatives are complete and adequate.

6.1 ALTERNATIVES CONSIDERED

The purpose of the review of the description of decommissioning alternatives other than those proposed by the licensee in the decommissioning plan is to ensure that the full range of reasonable decommissioning alternatives has been evaluated by the licensee. The Council on Environmental Quality's (CEQ's) "40 Most Asked Questions About the National Environmental Policy Act" (NEPA) discusses the treatment of alternatives in environmental documents and states that agencies must evaluate all reasonable alternatives, including the environmentally preferable alternative. Therefore the discussion of alternatives must include an evaluation of all reasonable alternatives, including the environmentally preferable alternative. As discussed in the CEQ Questions, the environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily this means the alternative that causes the least damage to the biological and physical environment. It also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources(see CEQ's 40 Most Asked Questions, 6a).

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 51.45

Regulatory Guidance

- CEQ's 40 Most Asked Questions About the NEPA

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what impacts result from each alternative identified by the licensee. The staff should verify that the following information is included in the discussion of each alternative, including the licensee's proposed alternative:

- A description of the facility if the alternative is employed;
- A summary of the health effects on adjacent communities if the alternative is employed;
- A summary of the impacts on community resources such as land use and property values;
- A summary of the impacts on the geology, hydrology, air quality and ecology in and around the site;
- A description of impacts on minority or low-income populations within a 1 kilometer (0.6 mile) radius of the center of the facility (urban location) or within a 6.4 kilometer (4 mile) radius of the center of the facility (rural location);
- If appropriate, an assessment of the potential for criticality;
- A summary of the irreversible and irretrievable commitment of resources;
- An analysis of the proposed alternative and other alternatives as required by 10 CFR 51.45(c); and
- A list of the permits, licenses, approvals, and other entitlements, and a discussion of the status of compliance with these requirements required in 10 CFR 51.45(d).

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above is included in the licensee’s evaluation of alternatives to the proposed decommissioning alternative. NRC regulations at 10 CFR Part 51 require that all reasonable alternatives will be identified. An otherwise reasonable alternative will not be excluded from discussion solely on the grounds that it is not within the jurisdiction of the NRC (10 CFR 51, Appendix A to Subpart A, item 5).

Reasonable alternatives include those that are practical or feasible from a common sense, technical, or economic standpoint, rather than simply being desirable from the standpoint of the applicant (CEQ’s 40 Most Asked Questions, 2a). In fact, an alternative that is outside NRC’s legal jurisdiction must still be analyzed if it is reasonable (CEQ’s 40 Most Asked Questions, 2b). A potential conflict with local, State, tribal, or Federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered and discussed. (CEQ’s 40 Most Asked Questions 2b). For instance, a local law that prohibits on-site disposal of radioactive waste might conflict with the licensee’s proposal, but that conflict would not be a sufficient basis to conclude that on-site disposal is not reasonable and that the alternative should not be considered in detail.

Alternatively, the fact that NRC regulations prohibit an alternative is not a sufficient reason to consider it an unreasonable alternative if it would have environmental advantages and would be technically feasible.

Many conceivable alternatives are not considered to be reasonable. Alternatives that offer no potential environmental or other advantage (e.g., cost savings) need not be considered. Other alternatives may have potential advantages, but the alternative may not be reasonable if the advantages are not sufficient to compensate for the alternative’s adverse aspects. For instance, an alternative of excavating buried wastes, sorting it to place the most radioactive wastes on the bottom, and reburying the remaining waste could reduce the potential dose to an intruder, but at considerable expense and relatively high doses to workers. In addition, many minor variations of alternatives can be invented. Unless these variations exhibit appreciably different impacts, they should not be analyzed as separate alternatives. Although the full spectrum of reasonable alternatives must be identified and evaluated, alternatives that are only minor variations of other alternatives are more likely to confuse the decision maker than to help clarify the decision.

Sample Evaluation Findings

The NRC staff has reviewed the information in the evaluation of the Decommissioning Alternatives in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 6 (“Alternatives Considered and Rationale for Chosen Alternative”). Based on this review, the NRC staff has determined that the licensee [insert name] has adequately described the impacts of all reasonable alternatives to the decommissioning alternative described in the decommissioning plan.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Licensees should be encouraged to present the information on all alternatives in a comparative format. Licensees should be encouraged to submit the information in electronic format.

6.2 RATIONALE FOR CHOSEN ALTERNATIVE

The purpose of the review of the license's rationale for which alternative to employ at the site is to ensure that the licensee has fully justified the alternative chosen and that alternative includes a consideration of reducing potential exposure to radiation at the facility to those that are as low as is reasonably achievable, as required in NRC regulations at 10 CFR Part 20.

Regulatory Requirements

None

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand why the licensee selected the preferred alternative described in the decommissioning plan.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the licensee has compared the impacts of each reasonable decommissioning alterative as described above, including the environmentally preferable alternative.

Sample Evaluation Findings

The NRC staff has reviewed the rationale for selecting the decommissioning alternative in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 6 ("Alternatives Considered and Rationale for Chosen Alternative"). Based on this review, the NRC staff has determined that the licensee [insert name] has adequately evaluated the impacts of all reasonable decommissioning alternatives.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 7.0
ALARA ANALYSIS

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/ Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support: -	Division of Waste Management - Environmental and Performance Assessment Branch	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the licensee has developed a decommissioning plan that ensures that doses to the average member of the critical group are As Low as Reasonably Achievable (ALARA). Information submitted should include: (1) a cost-benefit analyses (or qualitative arguments) for the preferred option of removing residual radioactivity to a level that meets or exceeds the applicable limit, and (2) a description of the licensee's preferred method for showing compliance with the ALARA requirement at the time of decommissioning.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the ALARA portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under “Areas of Review,” above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material supporting the optimized decommissioning plan to be reviewed is technical in nature, and specific detailed technical analysis may be necessary. Staff should evaluate a licensee’s or responsible party’s estimates of dose for various alternatives using the appropriate guidance in SRP 5.0. Staff should evaluate licensee’s or responsible party’s cost estimates using the guidance in SRP 15.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1402, 20.1403(a), 20.1403(e), and 20.1404(a)(3)

Regulatory Guidance

Appendix D of this SRP

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the basis for the licensee or responsible party’s conclusion that projected dose limit/residual radioactivity concentrations (hereafter, the decommissioning goal) are ALARA. The decommissioning goal should be established at the point that the incremental benefits equal the incremental costs. The staff’s review should verify that the following information is included in the description of the development of the decommissioning goal:

- A description of how the licensee or responsible party will achieve a decommissioning goal below the dose limit;
- A quantitative cost benefit analysis;
- A description of how costs were estimated; and
- A demonstration that the doses to the average member of the critical group are ALARA.

Note: In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the staff presumes, absent information to the contrary, that licensees or responsible parties that remediate building surfaces or soil to the generic screening levels do not need to demonstrate that these levels are ALARA. However, licensees or responsible parties should remediate their facility below these levels through practices such as good housekeeping. In addition, licensees or responsible parties should provide a description in the final status survey report of how these practices were employed to achieve the final activity levels.

EVALUATION FINDINGS

Evaluation Criteria

The staff review should verify that the qualitative descriptions provide reasonable assurance that the activities and decommissioning goal will result in doses that are ALARA. For example, both the “Statements of Consideration” for 10 CFR Part 20, Subpart E and the Final Generic Impact Statement (NUREG-1496) show that removal for offsite disposal of surface soil is not cost effective (i.e., beyond ALARA) for unrestricted release exposure scenarios. For purposes of an example, suppose the dose modeling at a site shows that the concentration of the nuclide of interest equal to 0.25 mSv (25 mrem) is 3.7 Becquerels per gram(Bq/g) [100 picoCuries per gram (pCi/g)]. The licensee commits to reducing the site average concentration to 2.8 Bq/g (75 pCi/g). Since these actions have already been shown to be beyond the requirements of ALARA, the licensee need not supply quantitative analysis. For many situations, licensees will need to prepare quantitative analyses of alternate decommissioning activities (e.g., removal for disposal versus burial in place) or decommissioning goals [3.7 Bq/g(100 pCi/g) vs. 2.8 Bq/g (75 pCi/g)]. The comparison of interest is the incremental difference in benefits and costs between the alternative and the preferred option(s).

Staff should ensure that the quantitative cost benefit analyses are developed using the methodology described in Appendix D as follows:

- Calculation of Benefits

Appendix D discusses five different possible benefits: (1) collective dose averted, (2) regulatory costs avoided, (3) changes in land values, (4) esthetics, and (5) reduction in public opposition. Numerical estimates will generally only be available for the first three benefits, if they are appropriate. Qualitative analysis of the benefits can be done especially if the costs are large (e.g., no matter what the change in land value is, the costs will exceed the benefits). In most comparisons between alternatives in the same class (e.g., both alternatives result in unrestricted release), the only important benefit will be the collective dose averted. In comparisons between restricted and unrestricted release, the other benefits can become important.

The collective dose averted is generalized as the incremental dose difference between the preferred option and the alternative. Therefore, the staff needs to ensure that the licensee has calculated the benefits correctly by using the correct population density, area, and averted dose. This may require technical analysis of the dose modeling, and the reviewer should use SRP 5.0
for these cases. If the licensee has used discounting, the staff should ensure that the proper rates were used. The licensee is not required to discount because the discount reduces the benefits of adverting dose in later time periods.

For compliance with 10 CFR 20.1403(a), one acceptable method of compliance is to demonstrate that clean-up to the unrestricted release criteria is beyond ALARA considerations. In this case, a beneficial estimate must include costs that would be avoided if the site were to released for unrestricted use, including calculation of site control and maintenance costs and should include estimation of the additional regulatory costs associated with termination of a restricted site (e.g., development of an environmental impact statement, public meetings, etc.).

The staff should ensure that the licensee has properly documented the basis for any estimates of changes in land values. Acceptable sources of such estimates include real estate agents familiar with the local area and the issues involved or governmental assessors (e.g., county, state, etc.).

- Calculation of Costs

The staff should verify that the licensee has adequately estimated the effective monetary costs of the incremental remediation by using the equations in Appendix D. For review of the calculated monetary costs of the incremental remediation, the staff should use SRP 15.1 “Financial Assurance: Cost Estimate,” with the following changes to review the incremental costs (this may require calculating total cost estimates for the preferred option and each alternative):

– The cost estimate should be based on actual costs expected to be incurred by decommissioning the facility and should not assume that the work will be performed by an independent third-party contractor;

– The cost estimate DOES take credit for (1) any salvage value that might be realized from the sale of potential assets during or after decommissioning, or (2) reduced taxes that might result from payment of decommissioning costs and/or site control and maintenance costs; and

– The decommissioning cost estimates should reflect the actual situation rather than maximized assumptions.

For each of the cost terms (e.g., disposal costs, worker fatalities, etc.) the incremental difference between the preferred and the alternate options may be negative (i.e., the alternative “costs” less than the preferred option).

Staff should verify that the licensee’s or responsible party’s proposed demonstration that doses to the average member of the critical group are ALARA. There are two approaches to demonstrate compliance with the ALARA requirement at the end of decommissioning: (1) a pre-determined acceptable dose limit or concentration guideline(s) or (2) an acceptable preferred option and decommissioning goal with organizational oversight and review during decommissioning. Both options have their own advantages and disadvantages. Establishment of the compliance method needs to be made by the licensee, with the staff reviewing the applicability, given the site-specific information.

- Pre-Determined Compliance Measure

Under the pre-determined compliance measure, the licensee would agree to meet the dose calculated for the preferred option or the radiological concentrations associated with this dose. This could be met by either establishing deterministic concentration limits for the site or agreeing to use a specified dose scenario with associated parameters and assumptions. If the licensee's final survey results meet the self-imposed concentration limits (or dose limit), the licensee has met the ALARA requirement.

- Performance-Based Compliance

Performance-based compliance allows a licensee to adjust its ALARA assessment during decommissioning to deal with actual site conditions experienced and actual costs incurred. The philosophy behind this compliance measure is very similar to how ALARA is handled during routine operations. The licensee's decommissioning plan needs to meet the following criteria to use this approach:

  - The preferred option, based on valid assumptions, would result in reducing residual activity to ALARA levels, as described above;
  - The licensee has established decommissioning guidelines (either dose or concentrations) based on the decommissioning plan's analysis;
  - The licensee has a documented method to review the effectiveness of the remediation activities. This method should include:
    - An ALARA committee (or Radiation Safety Officer, for small licensees) similar to operations requirements;
    - An appropriate review frequencies established;
    - An acceptable criteria on the scope of activities/commitments the ALARA committee can change;
    - A commitment for acceptable documentation of ALARA findings that result in the licensee making changes in its remediation activities or decommissioning guidelines; and
    - A commitment to provide annually to the NRC, all necessary page changes to the decommissioning plan due to ALARA findings.

At the end of remediation, a licensee using the performance-based approach will need to meet the following criteria:

- The final survey results satisfy the appropriate dose limit(s);

- Any substantial weaknesses in the ALARA program that were found during licensee audits or NRC inspections have been resolved; and

- Any deviation from the decommissioning goal presented in the decommissioning plan is properly justified by the ALARA committee findings (for long-term projects these should be reviewed annually by the project manager/inspection staff).

Sample Evaluation Findings

The staff has reviewed the information submitted by [name of licensee/facility] to demonstrate that the preferred decommissioning option is ALARA as required in 10 CFR Part 20, Subpart E, in accordance with the criteria in the NMSS Decommissioning Standard Review Plan, Section 7.0 (“ALARA Analysis”). Based on this review the staff concludes that the preferred option provides reasonable assurance that the remediation will result in residual radioactivity levels that are ALARA. The licensee has committed to showing compliance during remediation by [meeting the concentration limits established in the decommissioning plan/setting appropriate remediation goals’ and establishing a protocol to optimize the remediation activities during decommissioning].

SUGGESTED FORMAT

(1) Physical Specifications: See Appendix B
(2) Three to five paragraphs summarizing each of the items outlined in” Acceptance Criteria,” above, with appendices, if necessary.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 8.0
PLANNED DECOMMISSIONING ACTIVITIES

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Material Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch

Secondary: Division of Fuel Cycle Safety and Safeguards - Licensing Branch for issues associated with Integrated Safety Assessments

Support: None

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the planned decommissioning activities is adequate to allow the staff to fully understand the methods and procedures the licensee or responsible party intends to use to remove residual radioactive material at the site to levels that allow for release of the site in accordance with NRC requirements. This information should include descriptions of how the licensee or responsible party intends to remediate structures, systems and equipment, surface and subsurface soil, and surface and groundwater at the site. In addition, the licensee or responsible party should provide a schedule that demonstrates how the licensee will complete the interrelated decommissioning activities and the timeframes for completing the decommissioning. The licensee or responsible party should also summarize which activities are being performed by licensee or responsible party staff and those being performed by decommissioning contractors, including which activities are being performed under the licensee's license and which are being performed under the contractor's license.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the planned decommissioning activities portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will make a qualitative assessment as to whether the licensee's or responsible party's descriptions of planned decommissioning activities are adequate to serve as the basis for evaluating the licensee's or responsible party's methods and procedures for remediating the site and whether the decommissioning activities proposed by the licensee to remediate the facility can be conducted safely. In addition, the staff will ensure that the licensee's or responsible party's proposed schedule for completing the decommissioning complies with the NRC's requirements under 10 CFR 30.36(h), 10 CFR 40.42(h), 70.38(h), or 72.54(j). Finally, the staff will ensure that the licensee and contractor are already authorized to perform the decommissioning procedures described in the decommissioning plan or that the licensee has described the decommissioning procedures sufficiently to allow the staff to incorporate them into the license.

8.1 CONTAMINATED STRUCTURES

The purpose of the review of the description of the planned decommissioning activities for contaminated structures is to allow the staff to fully understand what methods and procedures the licensee or responsible party will undertake to remediate the contaminated structure. This will allow the staff to evaluate the licensee's methods and procedures to qualitatively assess if they can be performed safely and in compliance with NRC's requirements. This information may also aid the staff in evaluating the estimates of radioactive waste that will be generated during decommissioning, the cost estimates for the decommissioning, and the ALARA evaluations developed by the licensee or responsible party to support the decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g), 40.42(g), 70.38(g), and 72.54(g)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to remediate the contaminated structure. In addition, the information should be sufficient to allow the staff to determine if the licensee's or responsible party's radiation safety procedures are appropriate, given the level of contamination and proposed method(s) for remediation. The staff's review should verify that the following information is included in the authorized activities section of the facility decommissioning plan:

- A summary of the remediation tasks planned for each room or area in the contaminated structure in the order in which they will occur, including which activities will be conducted by licensee staff and which will be performed by a contractor;

- A description of the remediation techniques[1] (such as scabbling, hydrolazing or grit blasting) that will be employed in each room or area of the contaminated structure;

- A summary of the radiation protection methods (such as PPE, step-off pads and exit monitoring) and control procedures (such as scabbler shrouds, HEPA vented enclosures or superfine water misting) that will be employed in each room or area[2];

- A summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;

- A commitment to conduct decommissioning activities in accordance with written, approved procedures;

- A summary of any unique safety or remediation issues associated with remediating the room or area; and,

[1]Licensees or responsible party's may generically describe these techniques once at the beginning of the "Contaminated Structures" section and refer to them in the descriptions of the remediation of the individual rooms or areas

[2]The staff's technical review of the adequacy of the licensee's or responsible party's radiation safety procedures should be performed pursuant to the criteria in Section 10 of this SRP. In this section of the SRP the staff should make a qualitative assessment of the adequacy of the radiation protection and control methods proposed by the licensee or responsible party to determine if the procedures described in the Radiation Safety and Health section of the decommissioning plan have been followed.

- For Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

If the licensee or responsible party intends to dismantle structures with contamination present in excess of the unrestricted use limits, the decommissioning plan should provide a separate summary of the information listed above for the areas containing contamination in excess of the unrestricted use limits. In addition, the licensee or responsible party should provide a description of the techniques and procedures that will be used to dismantle the building or structure and the licensee's or responsible party's procedures for evaluating the areas prior to dismantlement.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the licensee or responsible party has described the remediation activities and associated safety precautions in sufficient detail to allow the staff to make a qualitative assessment of the adequacy of the proposed activities with respect to safety in compliance with NRC requirements. The staff should verify that the information summarized under "Information to be Submitted", above, is included in the licensee's description of the decommissioning activities portion of the decommissioning plan. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's proposed remediation methods and procedures to accomplish the remedation objectives in a manner that is protective of workers and the public and in compliance with NRC requirements. Detailed technical review of the safety precautions and procedures should be conducted pursuant to the criteria in Section 10 of this SRP.

Sample Evaluation Findings

The staff may combine the evaluation finding for the licensee's or responsible party's description of the planned decommissioning activities with the findings for the remaining areas in this section of the SRP as follows:

The NRC staff has reviewed the decommissioning activities described in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 8 (Planned Decommissioning Activities). Based on this review the NRC staff has determined that the licensee [insert name] has provided sufficient information to allow the NRC staff to evaluate the licensee's planned decommissioning activities to ensure that the decommissioning can be conducted in accordance with NRC requirements.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

2. Bullet 1 under “Acceptance Criteria,” above should be no more than 1or 2 pages outlining the tasks in tabular form. Bullet 2 should be 1 or 2 sentences for each room or area. Up to 3 paragraphs summarizing the information requested under bullets 3 and 4. Bullets 5 and 6 should be 1or 2 sentences. Bullet 7 should be no more than 1 paragraph in length. Licensees should be encouraged to submit the information in electronic format.

8.2 CONTAMINATED SYSTEMS AND EQUIPMENT

The purpose of the review of the description of the planned decommissioning activities for contaminated systems and equipment is to allow the staff to fully understand what methods and procedures the licensee or responsible party will undertake to remediate the contaminated systems or equipment at its facility. This will allow the staff to evaluate the licensee’s methods and procedures to qualitatively assess if they can be performed safely and in compliance with NRC’s requirements. This information may also aid the staff in evaluating the estimates of radioactive waste that will be generated during decommissioning, the cost estimates for the decommissioning, and the ALARA evaluations developed by the licensee or responsible party to support the decommissioning.

ACCEPTANCE CRITERIA

<u>Regulatory Requirements</u>

- 10 CFR 30.36(g), 40.42(g), and 70.38(g),

<u>Regulatory Guidance</u>

None

<u>Information to be Submitted</u>

The information supplied by the licensee should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to remediate the contaminated systems and equipment. In addition, the information should be sufficient to allow the staff to determine if the licensee’s or responsible party’s radiation safety procedures are appropriate, given the level of contamination and proposed method(s) for remediation.
The staff’s review should verify that the following information is included in the authorized activities section of the facility decommissioning plan:

- A summary of the remediation tasks planned for each system in the order in which they will occur, including which activities will be conducted by licensee staff and which will be performed by a contractor;

- A description of the techniques[3] (such as scabbling, hydrolazing or grit blasting) that will be employed to remediate each system in the facility or site;

- A description of the radiation protection methods (such as personal protective equipment (PPE), step-off pads and exit monitoring) and control procedures (such as scabbler shrouds, HEPA vented enclosures or superfine water misting) that will be employed while remediating each system[4];

- A summary of the equipment that will be removed or decontaminated and how the decontamination will be accomplished;

- A summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;

- A commitment to conduct decommissioning activities in accordance with written, approved procedures;

- A summary of any unique safety or remediation issues associated with remediating any system or piece of equipment; and

- For Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the licensee or responsible party has described the remediation activities and associated safety precautions in sufficient detail to allow the staff to determine if the proposed activities can be conducted safely and in compliance with NRC requirements. The staff should verify that the information summarized under "Information to be Submitted", above is included in the licensee's description of the decommissioning activities portion of the decommissioning plan. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's proposed remediation methods and procedures to accomplish the remedation objectives in a manner that is protective of workers and the public and in compliance with NRC requirements. Detailed technical review of the safety precautions and procedures should be conducted pursuant to the criteria in Section 10 of this SRP.

Sample Evaluation Findings

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[3]Licensees or responsible party's may generically describe these techniques once at the beginning of the "Contaminated Systems" section and refer to them in the descriptions of the remediation of the individual systems

[4]See footnote 2

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of decommissioning activities for contaminated systems and equipment with the findings for the remaining areas in this section of the SRP (see Section 8.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullet 1 under "Acceptance Criteria," above should be no more than 1or 2 pages outlining the tasks in tabular form. Bullet 2 should be 1 or 2 sentences for each system. Up to 3 paragraphs summarizing bullets the information requested under bullets 3 and 4. Bullet 5 should be a few pages and in tabular form. Bullets 6 and 7 should be 1or 2 sentences. Bullet 8 should be no more than 1 paragraph in length. Licensees should be encouraged to submit the information in electronic format.

8.3 SOIL

The purpose of the review of the description of the planned decommissioning activities for soil is to allow the staff to fully understand what methods and procedures the licensee or responsible party will undertake to remove or remediate the surface and subsurface soil at the site. This will allow the staff to evaluate the licensee's methods and procedures to qualitatively assess if they can be performed safely and in compliance with NRC's requirements. This information may also aid the staff in evaluating the estimates of radioactive waste that will be generated during decommissioning, the cost estimates for the decommissioning, and the ALARA evaluations developed by the licensee or responsible party to support the decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g), 40.42(g), and 70.38(g),

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to remove or remediate contaminated soil at the site. In addition, the information should be sufficient to allow the staff to determine if the licensee's or responsible party's radiation safety procedures are appropriate, given the level of contamination in the soil and proposed method(s) for removal or remediation. The staff's review should verify that the following information is included in the description of soil decommissioning activities in the facility decommissioning plan:

- A summary of the removal/remediation tasks planned for surface and subsurface soil at the site in the order in which they will occur including which activities will be conducted by licensee staff and which will be performed by a contractor;

- A description of the techniques that will be employed to remove or remediate surface and subsurface soil at the site;

- A description of the radiation protection methods (such as PPE, or area exit monitoring) and control procedures (such as the use of HEPA vented enclosures during excavation or covering soil piles to prevent wind dispersion) that will be employed during soil removal/remediation[5];

- A summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;

- A commitment to conduct decommissioning activities in accordance with written, approved procedures;

- A summary of any unique safety or removal/remediation issues associated with remediating the soil; and

- For Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the licensee or responsible party has described the .remediation activities and associated safety precautions in sufficient detail to allow the staff to determine if the proposed activities can be conducted safely and in compliance with NRC requirements. The staff should verify that the information summarized under "Information to be Submitted," above is included in the licensee's description of the decommissioning activities portion of the decommissioning plan. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's proposed remediation methods and procedures to accomplish the remedation objectives in a manner that is protective of workers and the public and in compliance with NRC requirements. Detailed technical review of the safety precautions and procedures should be conducted pursuant to the criteria in Section 10 of this SRP.

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[5]See footnote 2

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of decommissioning activities for soil with the findings for the remaining areas in this section of the SRP (see Section 8.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullet 1 under "Acceptance Criteria," above should be no more than 1or 2 pages outlining the tasks in tabular form. Bullet 2 should be 1 or 2 sentences for each area. Up to 3 paragraphs summarizing the information requested under Bullets 3 and 4. Bullets 5 and 6 should be 1 or 2 sentences. Bullet 7 should be no more than 1 paragraph in length. Licensees should be encouraged to submit the information in electronic format.

8.4 SURFACE AND GROUNDWATER

The purpose of the review of the description of the planned decommissioning activities for surface and groundwater is to allow the staff to fully understand what methods and procedures the licensee or responsible party will undertake to remediate the contaminated water. This will allow the staff to evaluate the licensee's methods and procedures to qualitatively assess if they can be performed safely and in compliance with NRC's requirements. This information may also aid the staff in evaluating the estimates of radioactive waste that will be generated during decommissioning, the cost estimates for the decommissioning, and the ALARA evaluations developed by the licensee or responsible party to support the decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g), 10 CFR 40.42(g), 70.38(g)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to remediate the contaminated ground or surface water. In addition, the information should be sufficient to allow the staff to determine if the licensee's or responsible party's radiation safety procedures are appropriate, given the level of contamination and proposed method(s) for remediation. The staff's review should verify that the following information is included in the authorized activities section of the facility decommissioning plan:

- A summary of the remediation tasks planned for ground and surface water in the order in which they will occur, including which activities will be conducted by licensee staff and which will be performed by a contractor;
- A description the remediation techniques that will be employed to remediate the ground or surface water;
- A description of the radiation protection methods and control procedures that will be employed during ground or surface water remediation[6];
- A summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;
- A commitment to conduct decommissioning activities in accordance with written, approved procedures; and
- A summary of any unique safety or remediation issues associated with remediating the ground or surface water.

EVALUATION FINDINGS

<u>Evaluation Criteria</u>

The staff's review should verify that the licensee or responsible party has described the remediation activities and associated safety precautions in sufficient detail to allow the staff to determine if the proposed activities can be conducted safely and in compliance with NRC requirements. The staff should verify that the information summarized under "Information to be Submitted," above is included in the licensee's description of the decommissioning activities portion of the decommissioning plan. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's proposed remediation methods and procedures to accomplish the remedation objectives in a manner that is protective of workers and the public and in compliance with NRC requirements. Detailed technical review of the safety precautions and procedures should be conducted pursuant to the criteria in Section 10 of this SRP.

<u>Sample Evaluation Findings</u>

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[6]See footnote 2

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of decommissioning activities for surface and ground water with the findings for the remaining areas in this section of the SRP (see Section 8.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullet 1 under Acceptance Criteria, above should be no more than 1or 2 pages outlining the tasks in tabular form. Bullet 2 should be 1 or 2 sentences for each area. 1-2 paragraphs summarizing the information requested under Bullets 3 and 4. Bullets 5 and 6 should be 1 or 2 sentences. Bullet 7 should be no more than 1 paragraph in length. Licensees should be encouraged to submit the information in electronic format.

8.5 SCHEDULES

The purpose of the review of the licensee's or responsible party's schedule is to determine whether it complies with NRC's requirements for the completion of decommissioning activities.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(h), 10 CFR 40.42(h), 70.38(h), and 72.54(j)

Regulatory Guidance

None

Information to be Submitted

The schedule supplied by the licensee should be sufficient to allow the staff to fully understand what activities will be performed to complete the decommissioning, the amount of time required to perform the activity and the timeframe for performing the activities. The staff's review should verify that the licensee or responsible party has included:

- A Gantt or PERT chart detailing the proposed remediation tasks in the order in which they will occur and including the amount of time required to perform each decommissioning activity and the initiation and completion dates for the activities;

- A statement acknowledging that the dates in the schedule are contingent on NRC approval of the decommissioning plan;

- A statement acknowledging that circumstances can change during decommissioning, and, if the licensee determines that the decommissioning cannot be completed as outlined in the schedule, the licensee or responsible party will provide an updated schedule to NRC; and,

- If the decommissioning is not expected to be completed within the timeframes outlined in NRC regulations at 10 CFR 30.36(h)(1), 10 CFR 40.42(h)(1), 70.38(h)(1), or 72.54(j)(1), the staff should verify that the licensee has requested an alternative schedule for completing the decommissioning and has addressed the criteria in NRC regulations at 10 CFR 30.36(h)(2)(i)(1-5), 10 CFR 40.42(h)(2)(i) (1-5), 70.38(h)(2)(i)(1-5), or 72.54(k)(1-5)

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the licensee's or responsible party's schedule for decommissioning its facility is in compliance with NRC requirements. The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of the decommissioning activities portion of the decommissioning plan.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of decommissioning activities for soil with the findings for the remaining areas in this section of the SRP (see Section 8.1, above)

SUGGESTED FORMAT

1. Schedule: PERT or Gantt chart
2. Discussion: 1-2 sentences addressing Bullets 2 and 3 above, 2-3 paragraphs addressing the criteria in Bullet 4 above.
3. Physical Specifications: See Appendix B

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 9.0
PROJECT MANAGEMENT AND ORGANIZATION

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the licensee's or responsible party's decommissioning project organization and management structure is sufficient to allow the staff to fully understand how the licensee or responsible party will ensure that it will exercise adequate control over the decommissioning project. This information should include a description of the management structure for the project, including individual organizational unit reporting responsibilities and lines of authority; a description of how radioactive material work procedures/practices (such as Radiation Work Permits) are developed reviewed, implemented, and managed; a description of the qualifications necessary for individuals performing the various project management and safety functions; a description of the relationship between the various organizational units within the decommissioning organization (such as remedial activities and health and safety units), including the responsibilities and authority to revise or stop work; a description of the licensee's or responsible party's training program; and a description of how contractors performing work at the facility will be managed during the decommissioning project.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the decommissioning project management portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will make a qualitative assessment as to whether the licensee's or responsible party's descriptions of the proposed decommissioning project management and organization are adequate to serve as the basis for concluding that the licensee's or responsible party's management program will ensure that the appropriate control will be exercised during decommissioning operations.

9.1 DECOMMISSIONING MANAGEMENT ORGANIZATION

The purpose of the review of the description of the decommissioning project management organization is to verify that the licensee or responsible party has a management organization and the personnel resources to ensure that the decommissioning of the facility can be completed safely and in accordance with NRC requirements.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the structure and functions of the decommissioning project management organization. The staff's review should verify that the following information is included in the description of the decommissioning project management organization:

- A description of the decommissioning organization, including descriptions of the individual decommissioning project units within the decommissioning project; organization, such as project management, health and safety, remedial activities, etc.;

- A description of the responsibilities of each of these decommissioning project units;

- A description of the reporting hierarchy within the decommissioning project management organization, including a chart or diagram showing the relationship of each decommissioning project unit to other project units and decommissioning project management; and

- A description of the responsibility and authority of each unit to ensure that decommissioning activities are conducted in a safe manner and in accordance with approved written procedures, including stop-work authority of each unit and the manner in which concerns about safety issues are managed within the overall decommissioning project.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of the decommissioning project management organization. NRC staff should verify that the descriptions of the decommissioning project management organization and individual project unit responsibilities are sufficiently detailed to allow the staff to understand the manner in which the organization will ensure that decommissioning will be conducted safely. The staff should verify that the individual project unit reporting hierarchy and lines of authority within the decommissioning project do not create conflicts that could compromise safety during decommissioning and that, as appropriate, individual units report directly to the unit responsible for overall decommissioning project management. The staff should verify that the individual project units, and individuals within each unit, have the responsibility and authority to bring safety concerns to decommissioning project management, and that stop-work authority is provided to the unit responsible for safety and health. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's proposed decommissioning management organization to accomplish the remediation objectives in a manner that is protective of workers and the public and in compliance with NRC requirements.

Sample Evaluation Findings

The NRC staff has reviewed the description of the decommissioning project management organization, position descriptions, management and safety position qualification requirements and the manner in which the licensee [insert name and license number of licensee] will use contractors during the decommissioning of its facility located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 9 ("Decommissioning Management Organization"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to allow the NRC staff to evaluate the licensee's decommissioning project management organization and structure to determine if the decommissioning can be conducted safely and in accordance with NRC requirements. (Note that this finding incorporates the results of the staff's assessment under Sections 9.2 - 9.5, below).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. 1-2 pages describing the information under each bullet above and a diagram showing the decommissioning project management organization and reporting authority. Licensees should be encouraged to submit the information in electronic format.

9.2 DECOMMISSIONING TASK MANAGEMENT

The purpose of the review of the description management of decommissioning tasks is to verify that all decommissioning activities will be conducted in accordance with written, approved procedures and that the licensee or responsible party has a methodology in place to manage the development, review, and maintain the procedures.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the manner in which the licensee or responsible party will evaluate decommissioning tasks and develop and manage the procedures necessary for conducting the tasks. The staff's review should verify that the following information is included in the description of decommissioning task management:

- A description of the manner in which the decommissioning tasks are managed, such as through the use of a RWPs[1];

[1]The term "RWP" will be used throughout this section to refer to the written procedure used to manage individual decommissioning tasks.

- A description of how individual decommissioning tasks are evaluated and how the RWPs are developed for each task;
- A description of how the RWPs are reviewed and approved by the decommissioning project management organization;
- A description of how RWPs are managed throughout the decommissioning project (i.e., how they are issued, maintained, revised, and terminated); and
- A description of how individuals performing the decommissioning tasks are informed of the procedures in the RWP, including how they are initially informed and how they are informed when an RWP is revised or terminated.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s description of the manner in which decommissioning tasks will be managed. The staff should verify that the licensee or responsible party will control decommissioning tasks through the use of written procedures. These procedures should be developed by individuals/units familiar with the physical and safety requirements necessary to complete the tasks safely. The procedures should be reviewed and approved by units responsible for physical, radiological, chemical, and occupational safety, as well as decommissioning project management. Note that NRC staff is not responsible for ensuring that physical, chemical or occupational safety procedures are adequate. Rather, the intent is to ensure that the licensee has an integrated approach for reviewing and approving procedures that could impact on radiological safety. Procedures should also undergo separate review by a group charged with ensuring that activities are conducted safely and in a manner that ensures that exposures to radiation are ALARA. Staff should verify that the licensee has a methodology to issue, modify (after appropriate review and approval), and terminate RWPs, as well as a program for ensuring that individuals performing the tasks are informed or trained in the procedures. The staff should make a qualitative assessment of the adequacy of the licensee’s or responsible party’s proposed decommissioning task management procedures to accomplish the decommissioning in a manner that is protective of workers and the public and in compliance with NRC requirements.

Sample Evaluation Findings

None. The staff should combine the assessment of this section of the decommissioning plan with Section 9.1 above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

2. 1 page summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees should be encouraged to submit the information in electronic format.

9.3 DECOMMISSIONING MANAGEMENT POSITIONS AND QUALIFICATIONS

The purpose of the review of the licensee’s decommissioning management positions and qualifications is to ensure that the licensee or responsible party has the personnel resources to safely conduct and manage the decommissioning of its facility.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.33(3), 40.32(b), 70.22(a)(6), and 72.28(a-d)
- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the responsibilities and minimum qualifications required for each of the management and safety related positions within the licensee’s or responsible party’s decommissioning project organization. The staff’s review should verify that the following information is included in the description of decommissioning positions and qualifications:

- A description of the duties and responsibilities of each management position in the decommissioning organization and the reporting responsibility of the position;

- A description of the duties and responsibilities of each chemical, radiological, physical and occupational safety-related position in the decommissioning organization, and the reporting responsibility of the position;

- A description of the duties and responsibilities of each engineering, quality assurance, and waste management position in the decommissioning organization and the reporting responsibilities of their respective positions;

- The minimum qualifications for each of the positions describe above, and the qualifications of the individuals currently occupying the positions (the licensee should also commit to providing the staff with the qualifications of any newly hired or replacements for these positions); and

- A description of all decommissioning and safety committees including the membership of the committees, the duties and responsibilities of each committee and the authority of each committee.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted”, above is included in the licensee’s description of the previous decommissioning activities carried out under the license. The staff should make a qualitative assessment of the adequacy of the licensee’s or responsible party’s decommissioning position and qualification requirements to ensure that the decommissioning can be conducted in a manner that is protective of workers and the public and in compliance with NRC requirements.

Sample Evaluation Findings

None. The staff should combine its assessment of this section of the decommissioning plan with Section 9.1 above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. One to two paragraphs outlining the duties and responsibilities of each of the positions/committees above. Minimum qualifications should be summarized in tabular form and the licensee should submit the *curriculum vitae* of the individuals currently occupying the positions. Licensees should be encouraged to submit the information in electronic format.

9.3.1 Radiation Safety Officer

The purpose of the review of the Radiation Safety Officer position is to ensure that a qualified individual is designated and empowered to oversee the licensee’s or responsible party’s radiation protection program. The RSO must be qualified by training and experience for the types and quantities of radionuclides that will be encountered during decommissioning operations, as well as the operations that will be undertaken to decommission the facility. In addition, the RSO must be empowered by the licensee or responsible party and be responsible for the implementation of the radiation protection program.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 33.13(c)(2), 33.14(b)(1), 34.42, 35.900, and 36.13(d)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to fully evaluate the qualifications, authority and responsibilities of the RSO. The staff's review should verify that the following information is included in the description of the RSO's qualifications, duties, and responsibilities:

- A description of the health physics and radiation safety education and experience required for individuals acting as the licensee's or responsible party's RSO;
- A description of the responsibilities and duties of the RSO; and
- A description of the specific authority of the RSO to implement and manage the licensee's or responsible party's radiation protection program, including the RSO's access and "stop-work" authority for all activities involving radioactive material at the site.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's or responsible party's description of the duties and responsibilities of the RSO. The staff should verify that the description of the RSO's duties and responsibilities are sufficiently detailed to allow the staff to determine whether the RSO can, and will be able to, oversee the site radiation protection program effectively. The staff should verify that the RSO has clearly defined authority and responsibility to oversee the radiation protection program, such that if conflicts arise regarding the appropriate manner in which to conduct the decommissioning, the RSO can ensure that the decommissioning will be conducted safely.

The RSO is adequately qualified if he/she meets the following criteria:

- Education: A bachelors's degree in the physical sciences, industrial hygiene or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiological protection. 2 years of relevant experience are generally considered equivalent to 1 year of academic study.
- Health physics experience: At least 1 year of work experience in applied health physics, industrial hygiene or similar work relevant to radiological hazards associated with site remediation. This experience should involve actually working

with radiation detection and measurement equipment, not simply administrative or "desk" work.

- Specialized knowledge: A thorough knowledge of the proper application and use of all health physics equipment used for the radionuclides present at the site, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to the radionuclides present at the site.

Note that if the RSO does not have the decommissioning experience indicated above, the RSO could be supported by a contractor or someone on his/her staff who does have the experience.

The description of the RSO's duties and responsibilities should include the responsibility and authority to: review and approve all procedures involving the use of radioactive material at the facility; review and approve individuals as radiation workers at the site; conduct audits and inspections to ensure that activities involving the use of radioactive material are being conducted safely; monitoring of materials use and storage areas at the site; oversee the inventory, ordering, receipt and shipment of all radioactive material and radioactive waste at the site; ensure that all personnel at the site are trained in site radiation safety procedures and practices; ensure that sealed sources are leak-tested per NRC requirements; respond to and investigate incidents and accidents involving radioactive material at the site; monitor and evaluate radiation worker exposures at the site; and, maintain all required records.

The RSO should have the authority and access to all areas involved in decommissioning or radioactive material usage at the site and the specific authority and responsibility to stop any operations that in the RSO's opinion are not being conducted safely.

Sample Evaluation Findings

None. The staff should combine their assessment of this section of the decommissioning plan with Section 9.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. See Section 9.3, above

9.4 TRAINING

The purpose of the review of the licensee's training program is to provide the staff with sufficient information to determine if the licensee can provide its employees with the training necessary to complete the decommissioning safely and in accordance with NRC requirements. Note that training related to the Radiation Health and Safety Program will be evaluated under Section 10.1.2 of this SRP.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 19, 30.33(3), 40.32(b), 70.22(a)(6), and 72.28(a), (b) and (d)
- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to determine whether the licensee has an acceptable program to train employees in the remediation and safety procedures that will be used to decommission the facility. The staff's review should verify that the following information is included in the description of the training program for the facility:

- A description of the radiation safety training that the licensee will provide to each employee including pre-employment, annual/periodic training and specialized training to comply with 10 CFR Part 19;

- A description of any daily worker "jobside" or "tailgate" training that will be provided at the beginning of each workday or job task to familiarize workers with job-specific procedures or safety requirements; and

- A description of the documentation that will be maintained to demonstrate that training commitments are being met.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above are included in the licensee's description of training at its facility. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's training programs to ensure that workers are adequately informed of the hazards, preventative measures, and procedures associated with performing each decommissioning task.

Sample Evaluation Findings

None. The staff should combine its assessment of this section of the decommissioning plan with Section 9.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to four pages summarizing the information under bullets 1 and 2 above, 1 page summarizing the information under bullet 3. Licensees should be encouraged to submit the information in electronic format.

9.5 CONTRACTOR SUPPORT

The purpose of the review of the licensee's description of interaction between the licensee or responsible party and contractors is to determine if the interactions will occur such that both licensee and contractor personnel are adequately protected and that the decommissioning can be conducted in accordance with NRC requirements.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine whether the licensee's or responsible party's radiation protection procedures are adequate to ensure the safety of contractor and licensee or responsible party personnel. The staff's review should verify that the following information is included in the discussion of contractor support at the facility:

- A summary of decommissioning tasks that will be performed by contractors, including the areas at the site where they will perform these tasks;

- A description of the management interfaces that will be in place between the licensee or responsible party's management and on-site supervisors, and contractor management and on-site supervisors;

- A description of the oversight responsibilities and authority that the licensee or responsible party will exercise over contractor personnel;

- A description of the training that will be provided to contractor personnel by the licensee or responsible party, and the training that will be provided by the contractor; and

- A commitment that the contractor will comply with all radiation safety and license requirements at the facility.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of contractor support at the site. The staff should make a qualitative assessment of the adequacy of the licensee's or responsible party's planned management interface procedures with contractor management to ensure that both licensee and contractor personnel are adequately informed of the hazards, preventative measures, and procedures associated with performing each decommissioning task. The staff will verify that the licensee has the authority and responsibility to ensure that contractor personnel perform decommissioning activities in accordance with all license commitments and NRC requirements. The staff will verify that all contractor personnel will receive adequate training (per the training program in Section 9.4 above) either as part of the licensee's or responsible party's training program or as part of the contractor's training program.

Sample Evaluation Findings

None. The staff should combine its assessment of this section of the decommissioning plan with Section 9.1, above.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in "Acceptance Criteria," above. Licensees should be encouraged to submit the information in electronic format.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 10.0
RADIATION SAFETY AND HEALTH PROGRAM
DURING DECOMMISSIONING

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The NRC staff will review the information supplied by the licensee or responsible party to determine if the health and safety measures to be used to control and monitor the impacts of ionizing radiation on workers comply with the NRC's regulations in 10 CFR Parts 19 and 20. The NRC staff will review only those parts of the applicant's Radiation Health and Safety Program (RH&SP) that were not previously approved in the original submission for a licensing action. The information requested should address the following aspects of the RH&SP program: a description of the radiation safety controls and types of monitoring to be used to ensure that internal and external exposures to workers are ALARA (including administrative procedures); a commitment in the licensee's RH&SP program to written procedures (and changes to procedures); a commitment to perform periodic inspections, audits, and to a record-keeping program.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the Radiation Safety and Health Program portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature. The staff will make a quantitative assessment as to whether the licensee's or responsible party's proposed health and safety program complies with the regulatory requirements in 10 CFR Parts 19 and 20 and is adequate to protect workers from ionizing radiation during decommissioning activities. The staff will assess whether the applicant's radiological safety measures for workers are commensurate with the risks associated with licensed activities as required by 10 CFR 20.1101.

10.1 RADIATION SAFETY CONTROLS AND MONITORING FOR WORKERS

10.1.1 Workplace Air Sampling Program

ACCEPTANCE CRITERIA

The purpose of the review of the description of the licensee's or responsible party's air sampling program is to verify if the licensee or responsible party has a program adequate to demonstrate compliance with the dose assessment requirements of 10 CFR 20.1204, the survey requirements in 10 CFR 20.1501(a)-(b), and the requirements in 10 CFR 20.1703(a)(3)(i)-(ii), when respirators are worn.

Regulatory Requirements

- 10 CFR 20.1204, 20.1501(a)-(b), 20.1502 (b), and 20.1703(a)(3)(I)-(ii)

Regulatory Guidance

- Regulatory Guide 8.25, Rev. 1, Air Sampling in the Workplace, June 1992

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the licensee's air sampling program under routine and emergency conditions. The staff's review should verify that the following information is included in the description of the licensee's air sampling program:

- A demonstration that the air sampling program is representative of the workers breathing zones and will be initiated whenever a worker's intake is likely to exceed the criteria in 20.1502(b);
- A description of the criteria used for selection of the placement of air samplers in work areas where potential for airborne hazards exists;
- A description of the criteria demonstrating that air samplers with appropriate sensitivities will be used; and that samples will be collected at appropriate frequencies;
- A description of the conditions under which constant air monitors (CAMs) (or similar equipment), general air and breathing zone samplers will be used, including a description of their readouts, annunciators, and alarm setpoints;
- A description of the criteria used to determine the frequency of calibration of the flow meters on the air samplers;
- A description of the action levels for air sampling results, including the actions to be taken when they are exceeded; and
- A description of how minimum detectable activities (MDAs) for each specific radionuclide that may be collected in air samples are determined.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the air sampling program proposed by the licensee or responsible party will be in compliance with 10 CFR 20.1204, 20.1501(a)-(b), 20.1502(b) 20.1703(a)(3)(I)-(ii), and Regulatory Guide 8.25. The staff shall verify that the licensee's or responsible party's air sampling program will:

- Require air samples when a worker's intake is likely to exceed the criteria in 20.1502(b), and will demonstrate that the air samples are representative of the air inhaled in any work areas in which a potential exists for airborne radioactive materials, as indicated in Regulatory Position 3 of Regulatory Guide 8.25;
- Provide the bases for selection of the locations of air samplers in all work areas in which a potential exists for airborne radioactivity as indicated in Regulatory Position 2 of Regulatory Guide 8.25;

- Measure air concentrations with sufficient sensitivity over the ranges of concentrations encountered in the various work areas, and with frequencies of sampling as indicated in Regulatory Position 1 of Regulatory Guide 8.25;

- Specify the conditions under which CAMs will be used, and provide a description of their readouts, annunciators, and alarm setpoints as indicated in Regulatory Position 1.6 of Regulatory Guide 8.25;

- Ensure that the frequency of calibration of the flow meters on the air samplers is as indicated in Regulatory Position 5 of Regulatory Guide 8.25;

- Provide action levels for air sampling results, actions to be taken when they are exceeded, and their technical bases as indicated in Regulatory Position 6.1 of Regulatory Guide 8.25; and

- Provide the MDA for each specific radio nuclide that may be collected in air samples as indicated in Regulatory Position 6.3 of Regulatory Guide 8.25.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.1 (Air Sampling Program). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information on when air samples will be taken in work areas , the types of air sample equipment to be used and where they will be located in work areas, calibration of flow meters, minimum detectable activities (MDA) of equipment to be used for analyses of radionuclides collected during air sampling, action levels for airborne radioactivity (and corrective actions to be taken when these levels are exceeded) to allow the NRC staff to conclude that the licensee's air sampling program will comply with 10 CFR 20.1204, 20.1501(a)-(b), 20.1502(b), 20.1703(a)(3)(I)-(ii), and Regulatory Guide 8.25.

10.1.2 Respiratory Protection Program

ACCEPTANCE CRITERIA

The purpose of the review of the description of the respiratory protection program is to verify that the measures used by the licensee or responsible party in its respiratory protection program adequately limit intakes of airborne radioactive materials for workers in restricted areas and to keep the total effective dose equivalent as low as is reasonably achievable (ALARA).

Regulatory Requirements

- 10 CFR 20.1101(b), 20.1701, 20.1702, 20.1703, and 20.1704

Regulatory Guidance

- Draft Regulatory Guide DG-8022, Acceptable Programs for Respiratory Protection
- NUREG-0041, Rev. 1, "Manual of Respiratory Protection Against Airborne Radioactive Material"

Information to be Submitted

The staff's review will verify that the licensee's or the responsible party's program description for respiratory protection will meet the requirements of 10 CFR 20.1101(b), 20.1701 - 20. 1704, Appendix A of 10 CFR Part 20, and of the guidance in Draft Regulatory Guide DG-8022. The staff's review should verify that the following information is included in the description of the licensee's respiratory protection program:

- A description of the process controls, engineering controls, or procedures to control concentrations of radioactive materials in air;

- A description of the evaluation that will be performed when it is not practical to apply engineering controls or procedures, and demonstrates that the use of respiratory protection equipment is ALARA;

- A description of the considerations used to demonstrate that respiratory protection equipment is appropriate for a specific task, based on the guidance on assigned protection factors (APR);

- A description of the medical screening and fit testing required before workers will use any respirator that is assigned a protection factor (APF);

- A description of the written procedures maintained to address all the elements of the respiratory protection program;

- A description of the use, maintenance, and storage of respiratory protection devices in such a manner that they are not modified and are in like-new condition at the time of issue;

- A description of the respiratory equipment users training program; and

- A description of the considerations made when selecting respiratory protection equipment to mitigate existing chemical or other respiratory hazards instead of (or in addition to) radioactive hazards.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the licensee's or responsible party's respiratory protection program will be in compliance with the requirements of 20.1101(b), 20.1701 - 20. 1704, Appendix A of 10 CFR Part 20, and of Draft Regulatory Guide DG-8022. The staff shall verify that the licensee's or the responsible party's program for respiratory protection for workers in restricted areas will:

- Apply process controls, engineering controls or procedures to control concentrations of radioactive materials in air as required by 10 CFR 20.1702 when practical;
- When it is not practical to apply engineering controls or procedures, perform an evaluation to show the use of respiratory equipment is ALARA as indicated in Regulatory Positions C.2.2 and C2.3 of Draft Regulatory Guide DG-8022;

- Consider which respiratory protection equipment is appropriate for a specific task based on the guidance on assigned protection factors (APF) in Regulatory Position C.2.3 of Draft Regulatory Guide DG-8022; (3) Require medical screening and fit testing before workers will use any respirator that is assigned a protection factor (APF) as indicated in Regulatory Position C5 of Regulatory Guide DG-8022;

- Maintain written procedures to address all the elements of the respiratory protection program as required by 10 CFR 20.1703 and as identified in Regulatory Position C3 of Regulatory Guide DG-8022;

- Use, maintain, and store respiratory protection devices in such a manner that they are not modified and are in like-new condition at the time of issue as indicated in Regulatory Position C4 of Regulatory Guide DG-8022;

- Establish and implement a program to train respirator users as indicated in Regulatory Position C5.2 of Regulatory Guide DG-8022;

-] Comply with the safety concerns as indicated in Regulatory Position C6 of Regulatory Guide DG-8022; and

- Consult the Occupational Safety and Health regulations of the Department of Labor when selecting respiratory protection equipment to mitigate existing chemical or other respiratory hazards instead of (or in addition to) radioactive hazards, as required by Footnote (a) of Appendix A of 10 CFR Part 20.

<u>Sample Evaluation Findings</u>

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.2 (Respiratory Protection Program). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to implement an acceptable respiratory protection program so as to allow the NRC staff to conclude that the licensee's program will comply with 10 CFR 20.1101(b), and 10 CFR 20.1701 to 20.1704 and Appendix A of 10 CFR Part 20.

10.1.3 Internal Exposure Determination

ACCEPTANCE CRITERIA

The purpose of the review of the description of the Internal Exposure Determination Program is to verify that the measures used by the licensee or responsible party to determine a worker's internal exposure complies with 10 CFR Part 20 and NRC guidance documents, focusing on techniques used to estimate intake of radionuclides by workers and the calculations necessary for the conversion of an intake to a committed effective dose equivalent, or to a total organ dose equivalent.

Regulatory Requirements

- 10 CFR 20.1101(b), 20.1201(a)(1), 20.1201 (d) and (e), 20.1204, and 20.1502(b),

Regulatory Guidance

- Regulatory Guide 8.9, Rev 1, "Acceptable Concepts, Models Equations, and Assumptions For A Bioassay Program;"
- Regulatory Guide 8.25, "Air Sampling in the Workplace;"
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses;"
- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus"

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to determine a worker's internal exposure. The staff's review should verify that the following information is included in the description of the licensee's program:

- A description of the monitoring to be performed to determine worker exposure during routine operations, special operations, maintenance and clean-up activities;

- A description of how worker intakes are determined using measurements of quantities of radionuclides excreted from, or retained in the human body. The licensee or responsible party will include in its description the following:

  - How frequencies for bioassay measurements for baseline, periodic, special, and termination assays are assigned;

  - How radioactivity measured in the human body by bioassay techniques are converted into worker intake;

  - Action levels for bioassay samples, actions to be taken when they are exceeded, and their technical bases;

- A description of how worker intakes are determined by measurements of the concentrations of airborne radioactive materials in the workplace. To determine worker intake by measurements of the concentrations of airborne radioactive materials in the workplace, the licensee or the responsible party will include the following:

- How airborne concentrations of radioactivity are measured;
- How airborne concentrations are converted to determine intakes;
- Action levels for a worker's intake based on dose, and actions to be taken when they are exceeded; and
- Action levels for a worker's intake based on chemical toxicity if soluble uranium is present in the work area.

- A description of how worker intakes, for an adult, a minor, and a declared pregnant woman are determined using any combination of the measurements above, as necessary; and
- A description of how worker intakes are converted into committed effective dose equivalent (and organ-specific committed dose equivalent), including how the intake of radioactivity by a declared pregnant woman will be converted into a dose to the embryo/fetus.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review shall verify that the measures used to determine a worker's internal exposure will be in compliance with 10 CFR 20.1101(b), 20.1201(a)(1), (d) and (e), 20.1204 and 20.1502(b). The staff shall verify that the licensee's or the responsible party's program to determine internal exposure will:

- Monitor workers who meet the criteria in 10 CFR 20.1502(b)(1) and (2) for potential internal exposures during routine operations, special operations, maintenance and clean-up activities;
- Determine worker intake by measurements of quantities of radionuclides excreted from, or retained in the human body by:
  - Assigning frequencies for bioassay measurements for baseline, periodic, special, and termination assays as indicated in Regulatory Position 2 in Regulatory Guide 8.9, Rev. 1;
  - Converting radioactivity measured in the human body by bioassay techniques into worker intake, as indicated in Regulatory Position 4 of Regulatory Guide 8.9, Rev. 1; and

- Providing action levels for bioassay samples, actions to be taken when they are exceeded, and their technical bases as indicated in Regulatory Position 2.3 of Regulatory Guide 8.9, Rev. 1.

- Licensees or responsible parties may also determine worker intake by measurements of the concentrations of airborne radioactive materials in the workplace by:

  - Measuring airborne concentrations of radioactivity as indicated in Section 10.3.1 this SRP;

  - Converting airborne concentrations to intakes as indicated in Regulatory Position 3.3 of Regulatory Guide 8.34;

  - Providing action levels for a worker's intake based on dose, and actions to be taken when they are exceeded (these will be found in Section 10.3.1 of this SRP); and

  - Providing action levels for a worker's intake based on chemical toxicity if soluble uranium is present in the work area as indicated in 10 CFR 20.1201(e);

- Determine worker intake for an adult, a minor, and a declared pregnant woman by any combination of the measurements above as may be necessary as required by 10 CFR 20.1204(a)(1)-(4);

- Convert worker intakes into committed effective dose equivalent (and organ-specific committed dose equivalent) as indicated in Regulatory Positions 4, 5 and 6 of Regulatory Guide 8.34. The intake of radioactivity by a declared pregnant woman shall be converted into a dose to the embryo/fetus as identified in Regulatory Position 2 (or 3) of Regulatory Guide 8.36; and

- Maintain worker internal exposures ALARA as required by 10 CFR 20.1101(b), and as described in Section 10.2.1 of this SRP.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.3 ("Internal Exposure Determination"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information on methods to calculate internal dose of a worker based upon measurements from air samples or bioassay samples to allow the NRC staff to conclude that the licensee's program to determine internal exposure will comply with 10 CFR 20.1101(b), 20.1201(a)(1), (d) and (e), 20.1204 and 20.1502(b).

10.1.4 External Exposure Determination

The purpose of the review of the description of the licensee's or responsible party's external exposure determination program is to verify if the licensee or responsible party has a program adequate to demonstrate that worker's external exposure program complies with 10 CFR Part 20 and NRC Guidance Documents. External exposure can be measured with dosimeters worn on the human body or calculated from measurements with appropriate instruments during surveys in areas where decommissioning activities are carried out.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1101(b), 20.1201, 20.1203, 20.1501(a)(2)(i), and (c), 20.1502(a), and 20.1601

Regulatory Guidance

- Regulatory Guide 8.4, "Direct-reading and Indirect-reading Pocket Dosimeters"
- Regulatory Guide 8.28, "Audible-Alarm Dosimeters"
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses"

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what methods, procedures, and techniques the licensee or responsible party intends to use to determine a worker's external exposure. The staff's review should verify that the following information is included in the description of the licensee's program:

- A description of the individual-monitoring devices which will be provided to workers who meet the criteria in 10 CFR 20.1502(a) and 20.1601 for external exposures;

- A description of the type, range, sensitivity, and accuracy of each individual-monitoring device;
- A description of the use of extremity and whole body monitors when the external radiation field is non-uniform;

- A description of when audible-alarm dosimeters and pocket dosimeters will be provided and a description of their performance specifications;

- A description of how external dose from airborne radioactive material is determined;

- A description of the procedure to insure that surveys necessary to supplement personnel monitoring are performed; and

- A description of the action levels for worker's external exposure, and the technical bases and actions to be taken when they are exceeded.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the measures used to determine a worker's external exposure will be in compliance with the requirements of 10 CFR 20.1101(b), 20.1201(c), 20.1203, 20.1501(a)(2)(i) and (c), 20.1502(a), and 20.1601, and the guidance in Regulatory Guides 8.4, 8.28 and 8.34. The staff shall verify that the licensee's or the responsible party's program to determine external exposure will:

- Provide individual-monitoring devices to workers who meet the criteria in 10 CFR 20.1502(a) and 20.1601 for external exposures;
- Provide a description of the type, range, sensitivity, and accuracy of each individual-monitoring device;
- Require that individual monitoring devices be worn near the location on the human body that is expected to receive the highest dose as required by 10 CFR 20.1201(c), and as indicated in Regulatory Positions C2.1 and C2.2 of Regulatory Guide 8.34;
- Require that all personnel dosimeters, which require processing to determine radiation dose, be processed and evaluated by a dosimetry processor that meets the criteria in 10 CFR 20.1501(c);
- Use extremity monitors when the external radiation field is non-uniform as indicated in Regulatory Position C2.3 of Regulatory Guide 8.34;
- Use only audible-alarm dosimeters and pocket dosimeters that meet the performance specifications identified in Regulatory Guide 8.28 and Regulatory Guide 8.4; respectively;
- Determine external dose from airborne radioactive material as required by 10 CFR 20.1203;
- Conduct a reasonable number of surveys to supplement personnel monitoring as required by Section 20.1501(a)(2)(i) as described in Section 10.4, Occupational ALARA program of the SRP; and
- Provide action levels for worker's external exposure, and actions to be taken when they are exceeded.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according t the NMSS Decommissioning Standard Review Plan, Section 10.1.4 ("External Exposure Determination"). Based upon this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information on methods to measure or calculate the external dose of a worker to allow the NRC staff to conclude that the licensee's program to determine external exposure will comply with the requirements of 10 CFR 20.1101(b), 20.1201(c), 20.1203, 20.1501(a)(2)(i) and (c), 20.1502(a), and 20.1601.

10.1.5 Summation of Internal and External Exposures

The purpose of the review of the licensee's or responsible party's description of its radiation monitoring program is to verify that the calculations and procedures used to sum external and internal doses satisfy the provisions of 10 CFR Part 20.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1202, 20.1208(c)(1), and (2), 20.2106

Regulatory Guidance

- Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data"
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses"
- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus"

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the calculations and procedures used in summing external and internal doses. The staff's review should verify that the following information is included in the licensee's or responsible party's program to sum internal and external doses:

- A description of how the internal and external monitoring results are used to calculate Total Organ Dose Equivalent (TODE) and Total Effective Dose Equivalent (TEDE) doses to occupational workers;

- A description of how internal doses to the embryo/fetus, which is based on the intake of an occupationally-exposed, declared, pregnant woman will be determined;

- A description of the monitoring of the intake of a declared, pregnant woman if determined to be necessary; and

- A description of the program for the preparation, retention and reporting of records for occupational radiation exposures;

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the method used to sum internal and external exposures will be in compliance with 10 CFR 20.1202, 20.1208(c)(1) and (2), and 20.2106. The staff shall verify that the licensee's or the responsible party's calculations to sum internal and external exposures will:

- Use the results of internal and external monitoring to calculate TODE and TEDE to occupational workers as indicated in Regulatory Positions 7.1-C7.3 of Regulatory Guide 8.34 (a sample calculation is can be found in the Appendix to Regulatory Guide 8.34);

- Sum the internal exposure to the embryo/fetus, which is based on the intake of an occupationally-exposed, declared pregnant woman (DPW) as indicated in Regulatory Positions C1 to C3 of Regulatory Guide 8.36, with external dose to the DPW to obtain the "dose equivalent" to the embryo/fetus;

- Monitor the intake of a DPW if her internal exposure is likely to exceed the intake criteria indicated in Regulatory Position C1.1 of Regulatory Guide 8.36; and

- Follow the program for the preparation, retention and reporting of records for occupational radiation exposures as indicated in Regulatory Guide 8.7, and as discussed in Section 10.2.3 of this SRP.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.5 ("Summation of Internal and External Exposures"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to conclude that the licensee's program for summation of internal and external exposures will comply with 10 CFR 20.1202 and 20.1208(c)(1) and (2), and 20.2106.

10.1.6 Contamination Control Program

The purpose of the staff's review of the licensee's or responsible party's description of its program to monitor and control contamination during decommissioning activities is to verify that it complies with the requirements of 10 CFR Part 20. This section focuses on surveys of skin, protective and personal clothing, fixed and removable surface contamination, transport vehicles, equipment (including ventilation surveys), and packages.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1501(a), 20.1702, 20.1906 (b), (d), and (f)

Regulatory Guidance

- Information Notice #97-55, “Calculation of Surface Activity for Contaminated Equipment and Materials”
- Regulatory Guide 8.21, “Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants”
- Regulatory Guide 8.23, “Radiation Surveys at Medical Institutions”
- Regulatory Guide 8.24, “Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication”
- Regulatory Guide 8.25, “Air Sampling in the Workplace”
- NUREG-1660, “Specific Schedules of Requirements for Transport of Specified Types of Radioactive Material Consignments”
- Branch Technical Position, “License Condition for Leak Testing Sealed Sources”

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand how the licensee will implement, and modify its contamination control program throughout the schedule phases of the decommissioning activities.

The staff’s review should verify that the following information is included in the description of the licensee’s contamination control program:

- A description of the written procedures to control access to, and stay time in, contaminated areas by workers if they are needed;

- A description of surveys to supplement personnel monitoring for workers during routine operations, maintenance, clean-up activities, and special operations;

- A description of the surveys which will be performed to determine the baseline of background radiation levels and radioactivity from natural sources for areas where decommissioning activities will take place;

- A description in matrix or tabular form which describes contamination action limits (that is, actions taken to either decontaminate a person, place or area, or restrict access, or modify the type or frequency of radiological monitoring);

- A description (included in the matrix or table mentioned above) of proposed radiological contamination guidelines for specifying and modifying the frequency for each type of survey used to assess the reduction of total contamination; and,

- A description of the procedures used to test sealed sources, and to insure that sealed sources are leaked tested at appropriate intervals.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review shall verify that the measures used to control contamination will be in compliance with the requirements of 10 CFR 20.1501(a); 20.1702, 20.1906 (b), (d) and (f); the guidance in Regulatory Guides 8.21, 8.23, 8.24, Rev. 1, and 8.25; and, for Part 70 licensees, the Fuel Cycle Branch Technical Positions for leak testing sealed sources. The staff shall verify that the licensee's or the responsible party's contamination control program during decommissioning operations (prior to the final status survey) will:

- Establish a program and written procedures to control access to, and stay time in, contaminated areas by workers as required by 10 CFR 20.1702;

- Require surveys to supplement personnel monitoring for workers during routine operations, maintenance, clean-up activities, and special operations;

- Require surveys to determine the baseline of background radiation levels and radioactivity from natural sources for areas where decommissioning activities will take place;

- Require surveys of air quality based on Regulatory Guide 8.25 as described in Section 10.3.1 of this SRP;

- Follow the procedures for surveys as indicated in Regulatory Position C.1, Types of Surveys, in Regulatory Guide 8.21, 8.23, or 8.24, Rev.1 (depending on the kind of nuclear facility being decommissioned);

- Propose and justify administrative limits for removable surface contamination that will be allowed for restricted and unrestricted areas before decontamination will be performed (Refer to Regulatory Position C.1 of the appropriate Regulatory Guide 8.21, 8.23 or 8.24,for an illustration of generic administrative limits for contamination of surfaces, and of generic limits for contamination of clothing to be worn inside and outside restricted areas. Refer to Regulatory Guide 1.86 and FC83-23 for an illustration of administrative limits for the uncontrolled release of equipment for sites with decommissioning plans approved before August 20, 1999; refer to Table 1 in 63 FR 64132, November 18, 1998 for acceptable license termination screening values of common radionuclides for building surface contamination; refer to NUREG-1660 for Limits of Contamination established by the Department of Transportation;

- Calculate the surface activity of contaminated materials with a 4-pi surface-efficiency factor for gamma emitters, and 2-pi surface-efficiency factor for beta emitters as required by NRC Information Notice No.7-55;

- Propose and justify administrative guidelines for the frequency for each type of survey used to assess trends in the reduction of total contamination during decontamination of each work area as indicated in Regulatory Position C.2 in the appropriate Regulatory Guide 8.21, 8.23 or 8.24, Rev. 1; and

- Leak-test sealed sources on a regular basis in accord with the guidance in Annex A.2.1of ANSI/HPS N43.6-1997 (or for Part 70 licenses, as indicated in NRC's Branch Technical Positions for Leak Testing, April 1993).

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.6 ("Contamination Control Program"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to control contamination on skin, on protective and personal clothing, on fixed and removable contamination on work surfaces, on transport vehicles, on equipment (including ventilation hoods), and on packages to allow the NRC staff to conclude that the licensee's contamination control program will comply with 20.1501(a), 20.1702, 20.1906 (b), (d); and (f) of 10 CFR Part 20. The staff has verified that the information summarized under "Evaluation Criteria" above is included in the licensee's description of the methodology used to control contamination at the facility.

SUGGESTED FORMAT

1. The information may be summarized in narrative format. However, licensees should be encouraged to present the material in tabular format to the maximum extent possible.

10.1.7 Instrumentation Program

The purpose of the staff's review is to verify that the licensee's or responsible party description of its instruments and equipment used to make quantitative radiation measurements during surveys are calibrated periodically and have sufficient sensitivity to detect the types and magnitudes of ionizing radiation. Instrumentation will be used to: conduct radiation and contamination surveys, sample airborne radioactivity, monitor radiation levels in work areas, monitor airborne radionuclides in effluents, monitor personal dose, and analyze environmental air, water, soil and vegetation samples.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1501(b) and (c)

Regulatory Guidance

- NUREG-1506, “Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria”
- NUREG-1507, “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions”
- NUREG-1549, “Decision methods for Dose Assessment to Comply With Radiological Criteria for License Termination”
- NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM)
- Table 10.1 of NCRP Report 127 “Operational Radiation Safety Program”, 1998

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand how the licensee or responsible party will implement and maintain its radiological instrumentation program. The staff’s review should verify that the following information is included in the licensee’s instrumentation program:

- A description of the instruments to be used to support the health and safety program including the manufacturer’s name, the intended use of the instrument, the number of units available for the intended use, the ranges on each scale, the counting mode and the alarm set-points;

- A description of instrumentation storage, calibration and maintenance facilities for instruments used in field surveys, including on-site facilities used for laboratory analyses of samples collected during survey;

- A description of the method used to estimate the Minimum Detectable Concentration (MDC) or Minimum Detectable Activity (MDA) (at the 95% confidence level) for each type of radiation to be detected;

- A description of the instrument calibration and quality assurance procedures;

- A description of the methods used to estimate uncertainty bounds for each type of instrumental measurement; and

- A description of air sampling calibration procedures or a statement that the instruments will be calibrated by an accredited laboratory.

EVALUATION FINDINGS

Evaluation Criteria

The staff’s review will verify that the licensee’s or the responsible party’s instrumentation program will meet the requirements of 10 CFR 20.1501(b) and (c) and the guidance in NUREG-1506, NUREG-1507 and NUREG-1575. The selection of the instruments to be used for each type of field survey or laboratory analysis should comply with the general guidance on selection of instruments during decommissioning activities as recommended in Sections 6.1-6.5.3 and Appendix H of NUREG-1575. The method used to estimate the MDC or MDA (at the 95 percent confidence level) for each type of radiation to be detected should comply with the methods recommended in Section 6.7 of NUREG-1575. Chapters 4 and 5 of NUREG-1507 provide additional information on the extent to which the ideal MDC and MDA values may be affected when a contaminated surface is covered by paint, dust, oil, or moisture. The description of the instrument calibration and quality assurance procedures should comply with Table 10.1 of NCRP Report 127; the description of the methods used to estimate uncertainty bounds for each type of instrumental measurement should comply with recommendations indicated in Section 6.8 of NUREG-1575

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.1.7 ("Instrumentation Program"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information on the sensitivity and the calibration of instruments and equipment to be used to make quantitative measurements of ionizing radiation during surveys to allow the NRC staff to conclude that the licensee's instrumentation program will comply with 10 CFR 20.1501(b) and (c)

10.2 NUCLEAR CRITICALITY SAFETY.

The purpose of the review of the description of the licensee's or responsible party's nuclear criticality safety program is to verify that the licensee or responsible party has an adequate program to maintain the criticality safety basis established in the facility's existing safety analyses.

It is essential that all operations and personnel involved in decommissioning maintain the safety basis as established in the facility's existing safety analyses. In principle, the criticality safety requirements and other Items Relied on for Safety (IROFS) resulting from Nuclear Criticality Safety Analysis (NCSA) or Integrated Safety Analysis (ISA) of plant processes will have covered all credible operations involving that process, including shutting the process down and rendering it safe by removal of all fissile material. However, decommissioning challenges this existing safety basis in two ways:

1) Firstly certain unique operations may not be covered by the existing safety analysis because decommissioning involves actions differing from normal shutdown, such as dismantlement or special decontamination;

2) Secondly decommissioning may involve the use of different personnel than normal operations.

Therefore, in selected cases new or updated safety analyses may be required. This is not a new provision, but is simply the existing fundamental Nuclear Criticality Safety standard from consensus standard ANSI/ANS 8.1 that:

"Before a new operation with fissionable materials is begun or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions."

This provision, although not usually present verbatim in the license, is normally implemented by specific commitments stated in the NCS section of the license application. To the extent that decommissioning operations are new, or involve changes to existing operations, compliance with the above fundamental standard means that re-analysis to assure subcriticality would be needed. Therefore, before decommissioning operations involving new steps are begun on processes that may contain fissionable material, a review of the NCSA or ISA for that operation must be conducted. It is expected that a summary of this review be submitted as part of the Decommissioning Plan. Staff should review this summary to assure completeness and adequacy of items relied on for safety during decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR Part 70 and 76.

Regulatory Guidance

- Regulatory Guide 3.71 and endorsed standards of ANSI/ANS Series 8.

Information to be Submitted

The staff's review will verify that the following information (at a minimum) is included in the licensee's NCS information:

- A description of how the NCS functions, including management responsibilities and technical qualifications of safety personnel, shall be maintained when needed throughout the decommissioning process;
- A description of how an awareness of procedures and other items relied on for safety shall be maintained throughout decommissioning among all personnel with access to systems that may contain fissionable material in sufficient amounts for criticality;
- A summary of the review of NCSA's or the ISA indicating either that the process needs no new safety procedures or requirements, or that new requirements or analysis have been performed; and,
- A summary of any generic NCS requirements to be applied to general decommissioning, decontamination, or dismantlement operations, including those dealing with systems that may unexpectedly contain fissionable material.

Acceptance Criteria

The description of NCS functions for decommissioning is acceptable if its implementation would reasonably assure the continuance of necessary NCS functions where and when needed throughout the decommissioning process.

The description of how an awareness of procedures and other items relied on for safety shall be maintained is acceptable if it provides for measures that would reasonably assure that all personnel with access to systems that might contain fissionable material will conform to necessary NCS requirements. To be acceptable the general methods for informing or training of personnel involved in decommissioning who are not qualified operators of processes with fissionable materials should be sufficient to assure that such personnel do not inadvertently violate safety requirements. It is not necessary that all such personnel be trained in the details of all NCS requirements of systems, but that they be aware that operations involving such systems where fissile material may be present are subject to NCS requirements. For instance, certain operations may need to be conducted under the supervision of appropriately trained personnel.

The summary of the review of NCSA's or the ISA is acceptable if it indicates, for each process that may contain fissionable material in amounts of concern, whether the analysis is already adequate to cover all operations needed for decommissioning, or that new analysis or requirements were developed to address decommissioning tasks. In addition, the reviewer should make a selection of individual processes that is representative of the whole facility , but based on risk. These selected safety analyses should then be reviewed for adequacy. The analyses are acceptable if they comply with the same criteria and commitments as for NCSA's applied during normal operations; namely, those specified in the license and plant procedures in conformance with the regulations and guidance. The guidance on acceptance NCS criteria includes the ANSI/ANS Series 8 standards endorsed by Regulatory Guide 3.71, as well as more detailed criteria in the Standard Review Plan applicable to the licensee.

The summary of generic NCS requirements for decommissioning is acceptable if they provide reasonable assurance that existing specific NCS requirements will be complied with despite the general dismantlement and decontamination operations involved in decommissioning. Specifically these requirements are acceptable if they provide, as necessary, reasonable assurance that potentially critical masses of fissionable material in unexpected but credible locations will be detected and safely dispositioned. The potential for mobilizing or moderating such material by introduction of fluids should be addressed, as well as changes in any other parameters affecting criticality.

EVALUATION FINDINGS

The results of staff's review of the licensee's submittal should be stated in the form of findings of fact and acceptability for compliance with the regulations as guided by this SRP. In particular, the evaluation should make findings as to the acceptability and adequacy of the items addressed by this SRP to provide reasonable assurance of protection of public health and safety from the risk of nuclear criticalities during decommissioning.

10.3 HEALTH PHYSICS AUDITS, INSPECTIONS AND RECORD-KEEPING PROGRAM.

The staff should review the applicant's proposed audit, internal inspection, and record-keeping procedures. The program should identify the scope of the audit and inspections, their frequency, the responsibilities of all participants in these programs, and any corrective actions to be taken if deficiencies are found.

ACCEPTANCE CRITERIA

Regulatory Requirements

Broad Scope Licensees:
- 10 CFR 33.13(c); 33.14(b); and 33.15(c)

All Licensees:
- 10 CFR 20.1101; and 20.2102

Regulatory Guidance

- Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action" , dated May 1, 1996
- NUREG-1460,"Guide to NRC Reporting and Record keeping Requirements" Rev 1, July 1994

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully evaluate the applicants executive management and RSO audit program established to insure compliance with license conditions, commitments and regulatory requirements. The staff review should verify that the following information is included in the description of the audit program:

- A general description of the annual program review conducted by executive management;

- A description of the records to be maintained of the annual program review and executive audits;

- A description of the types and frequencies of surveys and audits to be performed by the RSO and RSO staff. These surveys and audits should be frequent enough to ensure close communications and proper surveillance of individual radiation workers. Applicants should consider developing survey and audit schedules based on activity and use (e.g., highly contaminated areas or facilities involving volatile radioactive materials may be audited weekly or biweekly, moderately contaminated areas or facilities may be audited monthly, and slightly contaminated facilities may be audited quarterly). The audit program should include routine unannounced inspections;

- A description of the process used in evaluating and dealing with violations of NRC requirements or license commitments identified during audits;

- A description of the records maintained of RSO audits, for example, the date of each audit, name of person(s) who conducted the audit, persons contacted by the auditor(s), areas audited, audit findings, corrective actions, and follow-up.

EVALUATION FINDINGS

The staff's review should verify that the licensee's audit and recordkeeping program implemented to evaluate, control, and monitor health and safety procedures is appropriate and is consistent with the guidance in this SRP. The proposed audit program should insure timely identification and correction of health and safety issues, such that compliance with NRC's requirements for the protection of the public health and safety and the environment is insured.

Sample Evaluation Findings

The NRC staff has reviewed the description of the licensee's [insert name and license number of licensee] audit and record keeping program which the licensee will utilize during the decommissioning of its facility located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 10.3 ("Health Physics Audit, Inspection and Record-Keeping Program"). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information to allow the NRC staff to evaluate the licensee's executive management and RSO audit and record keeping program to determine if the decommissioning can be conducted safely and in accordance with NRC requirements.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 11.0
ENVIRONMENTAL MONITORING AND CONTROL PROGRAM

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Low-Level Waste and Decommissioning Projects Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The NRC staff will review the information submitted by the licensee or responsible party to determine if the environmental monitoring and control program complies with the regulatory requirements in 10 CFR Part 20 and if it is adequate to protect workers, the public, and the environment from ionizing radiation during decommissioning activities. The staff should verify that the licensee's or responsible party's radiological effluent management practices are adequate to ensure that radiological effluent levels are maintained within applicable standards and are as low as reasonably achievable (ALARA). The environmental monitoring and control program should include descriptions of: (1) the environmental exposure evaluations to be performed during decommissioning; (2) the effluent monitoring for radioactive material at potential points of release to the environment; and (3) the controls that the licensee or responsible party will use to ensure that radioactive material in effluents does not exceed applicable NRC, State, or local requirements.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the environmental monitoring and control program without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is technical in nature. The staff will make a quantitative assessment as to whether the licensee's or responsible party's proposed effluent monitoring and control program complies with the regulatory requirements in 10 CFR Part 20 and is adequate to protect workers, the public and the environment from ionizing radiation during decommissioning activities. The staff will assess whether the applicant's environmental monitoring and control measures are commensurate with the risks associated with the proposed decommissioning activities.

11.1 ENVIRONMENTAL ALARA EVALUATION PROGRAM

The purpose of the review of the description of the licensee's or responsible party's environmental ALARA evaluation program is to verify if the licensee or responsible party has a program adequate to demonstrate compliance with the requirements of 10 CFR Part 20 to maintain releases of radioactive material to the environment ALARA.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR Part 20.1101(b) and (d)

Regulatory Guidance

- Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities," July 1993
- Regulatory Guide 4.20, "Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees Other Than Power Reactors," December 1998

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the licensee's environmental evaluation activities and procedures. The staff's review should verify that the following information is included in the description of the licensee's environmental ALARA evaluation program:

- A description of ALARA goals for effluent control;
- A description of the procedures, engineering controls, and process controls to maintain doses ALARA (may be discussed under section 11.3, below);
- A description of the ALARA reviews and reports to management.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Evaluation Criteria," above, is included in the licensee's environmental ALARA evaluation program description. The staff should verify that the licensee's or responsible party's program for the management of radiological materials released to the environment complies with NRC requirements at 10 CFR Part 20, and that the program uses appropriate methods and procedures based upon recognized NRC's and other professional health physic organization's guidance documents.

The staff shall verify that the licensee's or responsible party's ALARA goals are a fraction (i.e., 10% to 20%) of the values in Appendix B, Table 2, Columns 1 and 2 and Table 3 and the external exposure limit in 10 CFR 20.1302(b)(2)(ii), or the applicable dose limit for members of the public. An approach is acceptable if it is consistent with guidance found in Regulatory Guide 4.20 and the description of the approach provides sufficient detail to demonstrate specific application of the guidance to the proposed operations. The licensee or responsible party shall use sound, commonly accepted, and well established procedures, engineering controls, and process controls to achieve ALARA goals for effluent minimization. These include filtration, encapsulation, adsorption, containment, recycling, leakage reduction, and the storage of materials for radioactive decay. Practices for large, diffuse sources such as contaminated soils or surfaces include covers, wetting during operations, and the application of stabilizers. In addition, the licensee or responsible party must demonstrate a commitment to reducing unnecessary exposure to members of the public and releases to the environment.

ALARA program management should include a commitment to perform annual reviews of the content and implementation of the environmental radiation protection program. This review includes an analysis of trends in release concentrations, environmental monitoring data, and radionuclide usage, a determination of whether operational changes are needed to achieve the ALARA effluent goals, and an evaluation of all designs for system installations or modifications.

The description shall also include a commitment to report the results to senior management along with recommendations for changes in facilities or procedures that are necessary to achieve ALARA goals.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 11 (“Environmental Monitoring and Control Program”). Based on this review, the NRC staff has determined that the licensee [insert name] has provided sufficient information on the staff to conclude that the licensee’s program will comply with 10 CFR Part 20.

Note that the results from the staff’s evaluation of the Environmental ALARA, Environmental Monitoring, and Effluent Control programs should be combined in this finding.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

11.2 EFFLUENT MONITORING PROGRAM

The purpose of the review of the description of the licensee’s or responsible party’s effluent monitoring program is to determine if the licensee or responsible party has an adequate program for the collection and analysis of airborne and liquid effluents, for assessing radiation exposures of members of the public, and demonstrating compliance with applicable regulations.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1301(a) and (d), 20.1302(a) and (b), 20.1501, 2001(a), 20.2003(a), 20.2103 (b), 20.2107(a), 20.2202(a), 20.2203(a), and 70.59.

Regulatory Guidance

- ANSI N13.1-1982, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities"
- ANSI N42.18-1980, "Specification and Performance of On-site Instrumentation for Continuously Monitoring Radioactive Effluents"
- NCRP Report No. 123, "Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground," January 1996
- NRC Information Notice 94-07, “Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR Part 20,” January 28, 1994
- NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)–Effluent Streams and the Environment"
- NRC Regulatory Guide 4.16, "Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants"

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand how the licensee will implement and conduct its effluent monitoring program. The staff's review should verify that the following information is included in the licensee's effluent monitoring program:

- A demonstration that background and baseline concentrations of radionuclides in environmental media have been established through appropriate sampling and analysis;
- A description of the known or expected concentrations of radionuclides in effluents;
- A description of the physical and chemical characteristics of radionuclides in effluents;
- A summary or diagram of all effluent discharge locations;
- A demonstration that samples will be representative of actual releases;
- A summary of the sample collection and analysis procedures, including the minimum detectable concentrations of radionuclides (if this information is not already described pursuant to Section 10 of this SRP);
- A summary of the sample collection frequencies;
- A description of the environmental monitoring recording and reporting procedures; and
- A description of the quality assurance program to be established and implemented for the effluent monitoring program (if this is not already described under Section 13 of this SRP).

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Evaluation Criteria", above is included in the licensee's description of its effluent monitoring program. The staff should verify that the licensee's or responsible party's program complies with NRC requirements at 10 CFR Part 20, and that the program uses appropriate methods and procedures based upon recognized NRC and other professional health physics organizations guidance documents. Concentrations of radioactive materials in airborne and liquid effluents as well as physical and chemical characteristics should be estimated based on operational data for the facility.

Releases shall be maintained below the limits in 10 CFR Part 20, Appendix B, Table 2 or below site specific limits established in accordance with 20.1302(c) and should be ALARA. NRC regulations require that licensees demonstrate that releases are maintained below the limits in

10 CFR Part 20 by calculation or measurement. If a licensee or responsible party elects to make this demonstration by calculation, the estimate should be based on the total volume of effluents (air or liquid) released from the facility during a year and the total activity of radioactive material possessed by the licensee during the year. The total activity of radioactive material may be adjusted to reflect the actual activity that could have been released in effluents, as long as the licensee or responsible can justify the adjustment through materials inventory and balance records.

If the licensee or responsible party elects to demonstrate compliance with NRC requirements by sampling, all liquid and airborne effluent discharge locations should be described and a description of how each location is monitored such that the samples collected are representative of the concentration and quantity of radiological material released to the environment should be included. A description of the effluents which are continuously sampled from radiological operations associated with the plant, such as laboratories, experimental areas, and storage areas should also be included.

For liquid effluents, representative samples should be taken at each release point for the determination of concentrations and quantities of radionuclides released to an unrestricted area, including discharges to sewage systems. For continuous releases, samples should be continuously collected at each release point. For batch releases, a representative sample of each batch should be collected. If periodic sampling is used in lieu of continuous sampling, the description should demonstrate that the samples are representative of actual releases. Sample collection frequencies are appropriate for the effluent medium and the radionuclide(s) being sampled if they are performed during activities that could generate effluents in the medium being sampled and the samples collected can be shown to be representative of the concentrations of radionuclides in the medium. Reporting procedures are adequate if they comply with the guidance specified in Regulatory Guide 4.16. Reports of the concentrations of principal radionuclides released to unrestricted areas in liquid and gaseous effluents should be provided and include the MDC for the analysis and the error for each data point.

If the licensee or responsible party believes that radioactivity in effluents is insignificant and will remain so during decommissioning and after license termination, a justification for this assertion shall be included. For the purposes of this SRP, an effluent is significant if the concentration averaged over a calendar quarter is equal to 10% or more of the applicable concentration listed in Table 2 of Appendix B to 10 CFR Part 20.

Sample Evaluation Findings

None. The staff should combine the findings with those of Section 11.1, above

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

11.3 EFFLUENT CONTROL PROGRAM

The purpose of the review of the description of the licensee's or responsible party's effluent control program is to verify that the licensee or responsible party has a program to control radioactive material in effluents and to comply with all applicable standards and permit requirements related to the release of radioactive material in effluents.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1301(a) and (d), 20.1302(a) and (b), 20.1501, 2001(a), 20.2003(a), 20.2103 (b), 20.2107(a), 20.2202(a), and 20.2203(a).

Regulatory Guidance

- Regulatory Guide 4.20, "Constraints on Releases of Airborne Radioactive Materials to the Environment for Licensees other than Power Reactors," December 1996.
- NRC Information Notice 94-23: "Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program," March 25, 1994
- IAEA, No. 16, "Manual on Environmental Monitoring in Normal Operations,", Vienna, 1996
- IAEA, No. 18, "Environmental Monitoring in Emergency Situations", Vienna, 1966
- IAEA, Safety Series No. 41, "Objectives and Design of Environmental Monitoring Programs for Radioactive Contaminants", Vienna, 1975
- NCRP Report No. 50, "Environmental Radiation Measurements," December 1976
- NCRP Report No. 123, "Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground," January 1996

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand how the licensee will implement and conduct its effluent control program. The staff's review should verify that the following information is included in the licensee's effluent control program:

- A description of the controls that will be used to minimize releases of radioactive material to the environment;

- A summary of the action levels and description of the actions to be taken should a limit be exceeded;

- A description of the leak detection systems for ponds, lagoons, and tanks;

- A description of the procedures to ensure that releases to sewer systems are controlled and maintained to meet the requirements of 10 CFR 20.2003, and

- A summary of the estimates of doses to the public from effluents and a description of the method used to estimate public dose.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Evaluation Criteria," above is included in the description of the licensee's effluent control program. The staff should verify that the licensee's or responsible party's program for the control of radiological materials released to the environment complies with NRC requirements at 10 CFR Part 20, and that the program uses appropriate methods and procedures based upon recognized NRC and other professional health physics' organizations guidance documents. The staff shall verify that the licensee has identified all possible effluent pathways, based on current and expected future site conditions, and evaluated the likelihood of releases via these pathways. The controls proposed by the licensee or responsible party to minimize releases of radioactive material to the environment should be based on well recognized industry practices and procedures.

Proposed action levels should be a fraction (10-20 percent) of limits and be justified. Action levels should be incremental, such that each increasing action level results in a more aggressive action to assure and control effluents. A slightly higher than normal concentration of a radionuclide in effluent triggers an investigation into the cause of the increase. In addition, an action level shall be specified that will result in the shutdown of an operation if this level is exceeded. These action levels should be selected on the likelihood that a measured increase in concentration could indicate potential violation of the effluent limits. Actions to be taken if the levels are exceeded should be described insufficient detail to allow the staff to fully understand the scope and results of the actions.

The description of the system(s) for the detection of leakage from ponds, lagoons, and tanks are adequate if they are based on well recognized engineering practices and allow for the intervention and response to leaks before radioactive material enters unrestricted areas.

Controls for releases to sewer systems shall meet the requirements of 10 CFR 20.2003, including (I) the material is water soluble; (ii) known or expected discharges meet the effluent limits of 10 CFR 20 Appendix B, Table 3; and (iii) the known or expected total quantity of radioactive material released into the sewer system in a year does not exceed 5 Ci (185 GBq) of ^{3}H, 1 Ci (37 GBq) of ^{14}C, and 1 Ci (37 GBq) of all other radioactive materials combined. Solubility is determined in accordance with the procedure described in NRC Information Notice 94-07. If the licensee proposes to demonstrate compliance with 10 CFR 20.1301 through a calculation of the total effective dose equivalent (TEDE) to the individual likely to receive the highest dose in accordance with 20.1302(b)(1), calculation of the TEDE by pathways analyses uses appropriate models and codes and assumptions that accurately represent the facility, the site, and the surrounding area; assumptions are reasonable; input data is accurate; all applicable pathways are considered; and the results are interpreted correctly. NCRP Report No. 123, "Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and

Ground," January 1996, provides acceptable methods for calculating the dose from radioactive effluents. Computer codes are acceptable tools for pathways analysis if the applicant is able to demonstrate that the code has undergone validation and verification to demonstrate the validity of estimates developed using the code for established input sets. Dose conversion factors used in the pathways analyses are acceptable if they are based on the methodology described in ICRP 30, "Limits for Intakes of Radionuclides by Workers" as reflected in Federal Guidance Report 11.

Sample Evaluation Findings

None. The staff should combine the findings from the review of the Effluent Control Program with the findings from Section 11.1, above

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 12.0
RADIOACTIVE WASTE MANAGEMENT PROGRAM

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the program for the management of radioactive waste generated as part of the decommissioning of the facility is adequate to allow the staff to fully understand the types of radioactive waste that will be generated by decommissioning operations and the manner in which the licensee will manage these wastes. This information will be used by the staff to ensure that the waste will be managed in accordance with NRC requirements, to support the staff's evaluation of the licensee's or responsible party's health and safety program, the evaluation of potential accidents and the licensee's or responsible party's cost estimates for decommissioning. This information should include descriptions of the types, volumes, and activities of radioactive waste generated by the decommissioning operations, a description of how the wastes will be stored, treated (if on-site treatment is anticipated), and packaged for transport and disposal, and the name and location of the facility where the licensee or responsible party intends to treat and/or dispose of the waste.

REVIEW PROCEDURES

Acceptance Review

The staff will review the decommissioning plan to ensure that, at a minimum, the decommissioning plan contains the information summarized under “Areas of Review,” above. Staff will review the radioactive waste management portion of the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of the information will be assessed during the detailed technical review. Staff will review the decommissioning plan table of contents and the individual descriptions under “Areas of Review,” above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will verify that the manner in which the licensee or responsible party intends to package the waste for transport and disposal is acceptable by comparing the descriptions of the waste and the packaging procedures with the relevant NRC regulations. The staff will verify that the waste disposal locations are appropriate for the wastes generated during decommissioning by comparing the waste generated by the decommissioning operations with publically available information on the types of wastes that are accepted by the disposal facility. The staff will make a qualitative assessment as to whether the licensee’s or responsible party’s descriptions of the types, volumes, and activities of radioactive waste generated by the decommissioning operations appear accurate (given the information presented in the facility radiological status section of the decommissioning plan) and if the descriptions of how the wastes will be stored and treated are appropriate for the types and volumes of wastes, as well as being protective of worker and public health and safety.

12.1 SOLID RADIOACTIVE WASTE

The purpose of the review of the description of the management of solid radioactive waste generated during decommissioning operations is to ensure that the manner in which the licensee or responsible party proposes to manage the waste will be protective of the public health and safety and that the waste will be treated and disposed of in accordance with NRC requirements. The information will also be used to support the staff’s evaluation of potential accidents and the licensee’s or responsible party’s cost estimates for decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR Part 20, Subpart K, 10 CFR 61.55, 61.56, 61.57, 71.5
- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types, volumes, and activities of solid radioactive waste generated during decommissioning operations and the manner in which the licensee intends to manage and dispose of the wastes. The staff's review should verify that the following information is included in the solid radioactive waste section of the facility decommissioning plan:

- A summary of the types of solid radioactive waste that are expected to be generated during decommissioning operations, including (but not limited to) soil, structural and component metal, concrete, activated components, contaminated piping, wood, and plastic;

- A summary of the estimated volume, in cubic feet, of each solid radioactive waste type summarized under bullet 1, above;

- A summary of the radionuclides (including the estimated activity of each radionuclide) in each estimated solid radioactive waste type summarized under bullet 1, above;

- A summary of the volumes of Classes A, B, C, and Greater-than-Class-C solid radioactive waste that will be generated by decommissioning operations;

- A description of how and where each of the solid radioactive wastes summarized under bullet 1, above, will be stored on-site prior to shipment for disposal;

- A description of how the each of the solid radioactive wastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal;

- If appropriate, how the licensee or responsible party intends to manage volumetrically contaminated material;

- A description of how the licensee or responsible party will prevent contaminated soil, or other loose solid radioactive waste, from being re-disbursed after exhumation and collection; and

- The name and location of the disposal facility that the licensee intends to use for each solid radioactive waste type summarized under bullet 1, above.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's description of the solid radioactive waste management program. The staff should verify that the licensee's or responsible party's program for the management of solid radioactive waste complies with NRC requirements at 10 CFR Part 20, Subpart K, 10 CFR 61.55, 61.56, 61.57 and 71.5. The staff should make a qualitative assessment of the accuracy of the licensee's or responsible party's descriptions of the types, volumes, and activities of the solid radioactive waste by comparing them with the information presented in the facility description, planned decommissioning activities, and radiological status portions of the decommissioning plan. The staff should make a qualitative assessment of the licensee's or responsible party's proposed methods to store solid radioactive waste prior to disposal and the manner in which volumetrically contaminated waste will be managed. The staff will verify that the waste disposal locations are appropriate for the solid wastes generated during decommissioning by comparing the solid waste generated by the decommissioning operations with publically available information on the types of solid wastes that are accepted by the disposal facility.

Sample Evaluation Findings

The staff may combine the evaluation finding for the licensee's or responsible party's description of solid radioactive waste management programs with the findings for the remaining areas in this section of the SRP, as follows:

The NRC staff has reviewed the licensee's descriptions of the radioactive waste management program for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 12("Radioactive Waste Management Program"). Based on this review, the NRC staff has determined that the licensee's [insert name] programs for the management of radioactive waste generated during decommissioning operations ensure that the waste will be managed in accordance with NRC requirements and in a manner that is protective of the public health and safety.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullets 1- 4 under Acceptance Criteria, above should be in tabular format. 1-2 paragraphs describing the program under each of the remaining bullets. Licensees should be encouraged to submit the information in electronic format.

12.2 LIQUID RADIOACTIVE WASTE

The purpose of the review of the description of the management of liquid radioactive waste generated during decommissioning operations is to ensure that the manner in which the licensee or responsible party proposes to manage the waste will be protective of the public health and safety and that the waste will be treated and disposed of in accordance with NRC requirements. The information will also be used to support the staff's evaluation of potential accidents and the licensee's or responsible party's cost estimates for decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR Part 20, Subpart K, 61.55, 61.56, 61.57, and 71.5

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types, volumes, and activities of liquid radioactive waste generated during decommissioning operations and the manner in which the licensee intends to manage and dispose of the wastes. The staff's review should verify that the following information is included in the liquid radioactive waste section of the facility decommissioning plan:

- A summary of the types of liquid radioactive waste that are expected to be generated during decommissioning operations;
- A summary of the estimated volume, in liters, of each liquid radioactive waste type summarized under bullet 1 above;
- A summary of the radionuclides (including the estimated activity of each radionuclide) in each liquid radioactive waste type summarized under bullet 1 above;
- A summary of the estimated volumes of Class A, B, C and Greater-than-Class-C liquid radioactive waste that will be generated by decommissioning operations;
- A description of how and where each of the liquid radioactive wastes summarized under bullet 1 above, will be stored on-site prior to shipment for disposal;
- A description of how the each of the liquid radioactive wastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal; and
- The name and location of the disposal facility that the licensee intends to use for each liquid radioactive waste type summarized under bullet 1,above

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above is included in the licensee’s description of the liquid radioactive waste management program. The staff should verify that the licensee’s or responsible party’s program for the management of liquid radioactive waste complies with NRC requirements at 10 CFR Part 20, Subpart K, 61.55, 61.56, 61.57 and 71.5. The staff should make a qualitative assessment of the accuracy of the licensee’s or responsible party’s descriptions of the types, volumes, and activities of liquid radioactive waste by comparing them with the information presented in the facility description, planned decommissioning activities, and radiological status portions of the decommissioning plan. The staff should make a qualitative assessment of the licensee’s or responsible party’s proposed methods to store liquid radioactive waste prior to disposal. The staff will verify that the waste disposal locations are appropriate for the liquid wastes generated during decommissioning by comparing the liquid waste generated by the decommissioning operations with publically available information on the types of liquid wastes that are accepted by the disposal facility.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of liquid radioactive waste management programs with the findings for the remaining areas in this section of the SRP (see Section 12.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullets 1- 4 under Acceptance Criteria, above should be in tabular format. 1-2 paragraphs describing the program under each of the remaining bullets. Licensees should be encouraged to submit the information in electronic format.

12.3 MIXED WASTE

The purpose of the review of the description of the management of mixed waste generated during decommissioning operations is to ensure that the manner in which the licensee or responsible party proposes to manage the mixed waste will be protective of the public health and safety and that the waste will be managed, treated and disposed of in accordance with NRC and Environmental Protection Agency (EPA), or EPA authorized State, requirements. The information will also be used to support the staff’s evaluation of potential accidents and the licensee’s or responsible party’s cost estimates for decommissioning.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR Part 20, Subpart K, 61.55, 61.56, 61.57, 71.5, and 40 CFR 260-270

Regulatory Guidance

“Low-level Mixed Waste, A RCRA Perspective for NRC Licensees”

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand the types, volumes, and activities of mixed waste generated during decommissioning operations and the manner in which the licensee intends to manage and dispose of the wastes. The staff’s review should verify that the following information is included in the mixed waste section of the facility decommissioning plan:

- A summary of the types of solid and liquid mixed waste that are expected to be generated during decommissioning operations;
- A summary of the estimated volumes, in cubic feet, of each solid mixed waste type summarized under bullet 1 above and in liters for each liquid mixed waste;
- A summary of the radionuclides (including the estimated activity of each radionuclide) in each type of mixed waste type summarized under bullet 1 above;
- A summary of the estimated volumes of Class A, B, C and Greater-than-Class-C mixed waste that will be generated by decommissioning operations;
- A description of how and where each of the mixed wastes summarized under bullet 1 above, will be stored on-site prior to shipment for disposal;
- A description of how the each of the mixed wastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal;
- The name and location of the disposal facility that the licensee intends to use for each mixed waste type summarized under bullet 1 above;
- A discussion of the requirements of all other regulatory agencies having jurisdiction over the mixed waste; and
- A demonstration that the licensee possess the appropriate EPA or State permits to generate, store and/or treat the mixed wastes.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under”Information to be Submitted”, above is included in the licensee’s description of the liquid radioactive waste management program. The staff should verify that the licensee's or responsible party's program for the management of mixed waste complies with NRC requirements at 10 CFR Part 20, Subpart K, 61.55, 61.56,   61.57 and 71.5. The staff should make a qualitative assessment of the accuracy of the licensee's or responsible party's descriptions of the types, volumes, and activities of mixed waste by comparing it to the information presented in the facility description, planned decommissioning activities, and radiological status portions of the decommissioning plan. The staff should make a qualitative assessment of the licensee's or responsible party's proposed methods to store mixed waste prior to disposal. The staff will verify that the waste disposal locations are appropriate for the mixed wastes generated during decommissioning by comparing the mixed waste generated by the decommissioning operations to publically available information on the types of mixed wastes that are accepted by the disposal facility. Note that the NRC staff is NOT responsible for ensuring that the licensee or responsible party's program complies with the requirements of 40 CFR 260-270 or the Department of Transportation regulations pertaining to the transportation of the hazardous component of the mixed waste. The staff should make a qualitative assessment of the acceptability of the licensee's or responsible party's descriptions of the methods they will employ to comply with the requirements of other agencies with regulatory responsibility for the mixed waste.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of mixed waste management programs with the findings for the remaining areas in this section of the SRP (see Section 12.1, above)

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Bullets 1- 4 under Acceptance Criteria, above should be in tabular format. 1-2 paragraphs describing the program under each of the remaining bullets. Licensees should be encouraged to submit the information in electronic format.

STANDARD REVIEW PLAN 13.0
QUALITY ASSURANCE PROGRAM

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the information supplied by the licensee to determine if the description of the quality assurance (QA) program is adequate to allow the staff to conclude that the licensee or responsible party has adequate controls in place to support the decommissioning. Further, if the licensee effectively implements the QA program described, the data collected should be accurate and of sufficient quality to justify the conclusions drawn from the information. This information should include a description of the organization responsible for implementing the QA program; a description of the QA program, including descriptions of the manner in which QA activities are controlled; a description of the manner in which QA program documents are controlled; a description of how measuring and test equipment is controlled; a description of how conditions adverse to quality are corrected; a description of the QA records that will be maintained; and, a description of the audits and surveillances that are performed as part of the QA program.

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the QA program without assessing the adequacy or completeness of the information contained therein. The adequacy of this information will be assessed during the staff's detailed review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed review.

Safety Evaluation

The material to be reviewed is informational in nature, and no specific detailed technical analysis is required. The staff will make a qualitative assessment as to whether the licensee's QA program is adequate to ensure that accurate, high-quality information is developed to support the decommissioning of the facility.

13.1 ORGANIZATION

The purpose of the review of the QA organization is to verify that the licensee or responsible party has an adequate organization, management philosophy, and the resources necessary to ensure that the information submitted to support the decommissioning is accurate and of sufficient quality to justify the conclusions drawn from the information.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The staff will review the licensee's description of its organizational structure to ensure that persons and organizations performing quality affecting activities have sufficient authority and freedom to identify quality problems, provide solutions, and verify that solutions have been implemented. The staff's review should verify that the following information is included in the description of the QA program organization:

- A description of the QA program management organization;

- A description of the duties and responsibilities of each unit within the organization and how delegation of responsibilities is managed within the decommissioning program;
- A description of how work performance is evaluated;
- A description of the authority of each unit within the QA program; and
- An organization chart of the QA program organization.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted" above is included in the licensee's or responsible party's description of the QA program. The staff should verify that the organization or individual responsible for submitting the license application exercises and retains the responsibility for the establishment and execution of the overall program. The staff should verify that major delegations of work are fully described and in each case organizational responsibilities and methods for control of the work by the applicant are described, including how responsibility for delegated work is to be retained and exercised. The staff should verify that the licensee or responsible party and its prime contractors describe how responsibility is exercised for the overall QA program and that the extent of management responsibility and authority are addressed. The staff should verify that policies regarding the implementation of the QA program are documented and made mandatory.

The staff should verify that the licensee or responsible party and its contractors will evaluate the performance of work delegated to other organizations, including audits and surveillances of the contractor's QA programs and audits and surveillances of subcontractors, consultants, and vendors furnishing equipment or services to the applicant or its contractors. The frequency and method of this evaluation should be specified.

The staff should verify that the licensee or responsible party and prime contractors identify a management position that retains overall authority and responsibility for the QA program (normally, this position is filled by the QA Manager).The staff should verify that the QA Manager position is at the same, or at a higher organization level than the position of the highest line manager directly responsible for performing activities affecting quality (such as engineering, procurement, construction, and operation) and is sufficiently independent from cost and schedule restraints (this does not mean that the QA position must report outside of the project or program). The staff should verify that the authority and duties of persons and organizations performing functions related to meeting the performance objectives are clearly established and delineated in writing, including both the performing functions of attaining the requisite quality of work (quality achieving) and the assurance functions of verifying the attainment of quality (quality assuring). The staff should verify that designated QA personnel, sufficiently free from direct pressures resulting from cost and schedule, have the responsibility, delineated in writing, to stop unsatisfactory work and control further processing, or delivery of nonconforming material.

The staff should verify that persons and organizations performing quality assuring functions have sufficient authority and organizational freedom to (1) identify quality problems, (2) initiate, recommend, or provide solutions through designated channels, and (3) verify implementation of solutions. The staff should verify that persons and organizations with the above authority are identified and a description of how those actions are carried out is provided.

The staff should verify that provisions are established for the resolution of disputes involving quality arising from a difference of opinion between QA personnel and other department personnel. The staff should verify that the position description ensures that the individual directly responsible for the definition, direction, and effectiveness of the overall QA program has sufficient authority to effectively implement responsibilities. This position is to be sufficiently free from cost and schedule responsibilities.

The staff should verify that the person responsible for the on-site QA program is identified by position and has the appropriate organizational position, responsibilities, and authority to exercise proper control over the QA program.

The staff should verify that organization charts clearly identify all the on-site and off-site organizational elements that function under the cognizance of the QA program.

<u>Sample Evaluation Findings</u>

The NRC staff has reviewed the Quality Assurance Program for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 13 (“QA Program”). Based on this review, the NRC staff has determined that the licensee’s [insert name] QA program is sufficient to ensure that information submitted to support the decommissioning of its facility should be of sufficient quality to allow the staff to determine if the licensee’s planned decommissioning activities can be conducted in accordance with NRC requirements. (Note that this finding incorporates the results of the staff’s assessment of the entire QA program as described in the following subsections of Section 13).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.2 QUALITY ASSURANCE PROGRAM

The purpose of the review of the QA program is to verify that the licensee’s or responsible party’s QA program and activities affecting quality will be controlled by written policies, procedures and instruction, which if effectively implemented, should ensure that the information submitted to support the decommissioning is accurate and of sufficient quality to justify the conclusions drawn from the information.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii),40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The staff will review the licensee's or responsible party's QA program to determine if activities affecting quality will be conducted in accordance with written policies, procedures, and instructions, and that activities affecting quality are accomplished by suitably trained and qualified individuals. The staff shall review the licensee's QA program to ensure that quality affecting activities are prescribed by documented procedures, drawings, or instructions. The staff will verify that the following information is included in the description of the QA program:

- A commitment that activities affecting the quality of site decommissioning will be subject to the applicable controls of the QA program and activities covered by the QA program are identified on program defining documents;
- A brief summary of the company's corporate QA policies;
- A description of provisions to ensure that technical and quality assurance procedures required to implement the QA program are consistent with regulatory, licensing, and QA program requirements and are properly documented and controlled;
- A description of the management reviews, including the documentation of concurrence in these quality-affecting procedures;
- A description of the quality-affecting procedural controls of the principal contractors, including documentation of the acceptance of the controls before the initiation of activities affected by the program;
- A description of how NRC will be notified of changes (a) for review and acceptance in the accepted description of the QA program as presented or referenced in the decommissioning plan before implementation and (b) in organizational elements within 30 days after the announcement of the changes (Note: Editorial changes or personnel reassignments of a nonsubstantive nature do not require NRC notification);

- A description is provided of how management (above or outside the QA organization) regularly assesses the scope, status, adequacy, and compliance of the QA program;

- A description of the instruction provided to personnel responsible for performing activities affecting quality pertaining to the purpose, scope, and implementation of the quality-related manuals, instructions, and procedures;

- A description of the training and qualifications of personnel verifying activities affecting quality in the principles, techniques, and requirements of the activity being performed;

- For formal training and qualification programs, documentation includes the objectives and content of the program, attendees, and date of attendance;

- A description of the self-assessment program to confirm that activities affecting quality comply with the QA program;

- A commitment that persons performing self-assessment activities are not to have direct responsibilities in the area they are assessing;

- A description of the organizational responsibilities for ensuring that activities affecting quality are (a) prescribed by documented instructions, procedures, and drawings; and, (b) accomplished through implementation of these documents; and

- A description of the procedures to ensure that instructions, procedures, and drawings include quantitative acceptance criteria (such as those pertaining to dimensions, tolerances, and operating limits) and qualitative acceptance criteria (such as workmanship samples) for determining that important activities have been satisfactorily performed.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted” above, is included in the description of the QA program.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.3 DOCUMENT CONTROL

The purpose of the review of the licensee's or responsible party's description of how QA program documents are issued and amended is to ensure that adequate control is exercised over the development, issuance and revision of the documents.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii),40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to understand how the licensee or responsible party will develop, issue and revise documents associated with the QA program. The staff's review should verify that the following information is included in the description of the QA document control program:

- A summary of the types of QA documents that are included in the program; and

- A description of how the licensee or responsible party develops, issues, revises and retires QA documents.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's or responsible party's description of the QA document control program. The staff should verify that the scope of the document control program is described, and the types of controlled documents are identified. As a minimum, controlled documents include (1) quality assurance and quality control manuals and quality-affecting procedures, (2) technical reports. The staff should verify that procedures for the review, approval, and issuance of documents and changes will be established and described to ensure technical adequacy and inclusion of appropriate quality requirements before implementation. The staff should verify that procedures will be established to ensure that changes to documents are reviewed and approved by the same organizations as those that performed the initial review and approval or by other qualified responsible organizations delegated by the applicant. The staff should verify that procedures will be established to ensure that documents are available at the location where the activity will be performed prior to commencing work. The staff should verify that procedures will be established to ensure that obsolete or superseded documents are removed and replaced by applicable revisions in work areas in a timely manner.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.4 CONTROL OF MEASURING AND TEST EQUIPMENT

The purpose of the review of the description of the test and measurement equipment calibration program is to verify that the licensee or responsible has a program to ensure that equipment used to support decommissioning activities is properly controlled, calibrated, and maintained.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to fully understand the methods and procedures that the licensee or responsible party will use to ensure that only accurate, calibrated, test and measurement equipment will be used during the decommissioning project. The staff's review should verify that the following information is included in the description of the test and measurement equipment QA program:

- A summary of the test and measurement equipment used in the program;
- A description of how and at what frequency the equipment will be calibrated;
- A description of the daily calibration checks that will be performed on each piece of test or measurement equipment; and
- A description of the documentation that will be maintained to demonstrate that only properly calibrated and maintained equipment was used during the decommissioning.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's or responsible party's description of the test and measurement equipment program. The staff should verify that the scope of the program for the control of measuring and test equipment is described and the types of equipment to be controlled are established. The staff should verify that QA and other organizations' responsibilities are described for establishing, implementing, and ensuring effectiveness of the calibration and adjustment program. The staff should verify that procedures will be established for calibration (technique and frequency), maintenance, and control of the measuring and test equipment. The review of and documented concurrence in these procedures are described, and the organization responsible for these functions is identified. The staff should verify that measuring and test equipment is identified and traceable to the calibration test data. The staff should verify that measuring and test equipment will be labeled or tagged or "otherwise controlled" to indicate due date of the next calibration. The method to "otherwise control" equipment should be described. The staff should verify that measuring and test equipment will be calibrated at specified intervals on the basis of the required accuracy, purpose, degree of usage, stability characteristics, and other conditions affecting the measurement.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.5 CORRECTIVE ACTION

The staff will review the licensee's QA program to ensure that measures have been established to assure that conditions adverse to quality are promptly identified and corrected.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii),40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to determine whether adequate procedures and controls are in place to identify and correct conditions that will adversely affect quality. The staff's review should verify that the following information is included in the description of the corrective action program portion of the QA program:

- A description of the corrective action procedures for the facility, including a description of how the corrective action is determined to be adequate; and
- A description of the documentation maintained for each corrective action and any follow-up activities by the QA organization, after the corrective action is implemented.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's or responsible party's description of the corrective action. The staff should verify that procedures will be established for a corrective action program and that the QA organization reviews and documents concurrence in the procedures. The staff should verify that corrective action will be documented and initiated following the determination of a condition adverse to quality (such as nonconformance, failure, malfunction, deficiency, deviation, and defective material and equipment) to preclude recurrence. The staff should verify that the QA organization will be included in the concurrence chain regarding the adequacy of the corrective action. The staff should verify that follow-up action will be taken by the QA organization to verify the proper implementation of corrective action and to close out the corrective action in a timely manner. The staff should verify that significant conditions adverse to quality, the cause of the conditions, and the corrective action taken to preclude repetition will be documented and reported to immediate management and upper levels of management for review and assessment.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.6 QUALITY ASSURANCE RECORDS

The purpose of the review of the QA records program is to verify that the licensee or responsible party has procedures and facilities in place to adequately maintain and store the QA program records.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii),40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to fully understand the types of procedures that will be in place to manage the QA program records. The staff should verify that the following information is included in the description of the QA records program:

- A description of the manner in which the QA records will be managed;

- A description of the responsibilities of the QA organization as well as all other units involved in the decommissioning to implement and maintain QA records; and

- A description of the QA records storage facility.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the licensee’s or responsible party’s description of the QA records program. The staff should verify that the QA records program is described, and includes results of reviews, inspections, tests, audits, and material analyses; monitoring records of work performance; and records on the qualification of personnel, procedures, and equipment. The staff should verify that QA and other organizations are identified and their responsibilities are described for the definition and implementation of activities related to QA records. The staff should verify that suitable facilities for the storage of records are described and satisfy the requirements of ANSI/ASME NQA-1. Alternatives to the fire protection rating provisions are acceptable if record storage facilities conform to National Fire Protection Association Standard NFPA 232, Class 1, for permanent records and if the 2-hour fire-rating requirement contained in proposed ANSI N45.2.9 is met by the applicant in any one of the following three ways: (1) a 2-hour-rated vault meeting NFPA 232, (2) 2-hour-rated file containers meeting NFPA 232 (Class B), or (3) a 2-hour-rated fire resistant file room meeting NFPA 232.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee’s or responsible party’s description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

13.7 AUDITS AND SURVEILLANCES

The purpose of the staff’s review of the licensee’s or responsible party’s description of audits and surveillances is to ensure that the licensee has a comprehensive system of audits planned to verify compliance with all aspects of the QA program, and to determine the effectiveness of the QA program.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii),40.28(b)(3), 70.22(f), 70.38(g)(4)(ii), and 72.54(g)(6)

Regulatory Guidance

None

Information Criteria

The information supplied by the licensee's or responsible party's should be sufficient to allow the staff to determine if the of audit and surveillance program is adequate to ensure that a comprehensive system of audits planned to verify compliance with all aspects of the QA program is in place to determine the effectiveness of the QA program. The following information should be included in the description of the audit program:

- A description of the audit program, including the procedures for conducting the audits or surveillances;
- A description of the records and documentation generated during the audits and the manner in which the documents are managed;
- A description of all followup activities associated with audits or surveillances; and
- A description of the trending/tracking that will be performed on the results of audits and surveillances.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted," above, is included in the licensee's or responsible party's description of the audits program for the facility. The staff should verify that audits and surveillances will be performed in accordance with pre-established written procedures or checklists and conducted by trained personnel not having direct responsibilities for the achievement of quality in the areas being audited. The staff should verify that audit and surveillance results will be documented and then reviewed with management having responsibility in the area audited. The staff should verify that provisions exist such that appropriate follow-up corrective action to audit and surveillance reports will be undertaken by responsible management. Auditing organizations schedule and conduct appropriate follow-up to assure that the corrective action is effectively accomplished. The staff should verify that both technical and QA programmatic audits and surveillances will be performed to provide a comprehensive independent verification and evaluation of procedures and activities affecting quality. The staff should verify that audits and surveillances objectively assess the effectiveness and proper implementation of the QA program and address the technical adequacy of the activities being conducted. The staff should verify that provisions will be provided such that audits and surveillances are required to be performed in all areas where the requirements of the QA program are applicable. The staff should verify that audit and surveillance deficiency data are analyzed and trended. The staff should verify that reports which indicate quality trends and the effectiveness of the QA programs will be given to management for review, assessment, corrective action and follow up.

Sample Evaluation Findings

None. The staff should combine the evaluation finding for the licensee's or responsible party's description of the QA program with the finding for the remaining areas in this section of the SRP (see Section 13.1, above).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B. Licensees should be encouraged to submit the information in electronic format.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 14.0
FACILITY RADIATION SURVEYS

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	None	

AREAS OF REVIEW

The staff will review the radiological characterization survey results to determine whether the characterization survey provides sufficient information to permit planning for site remediation that will be effective and will not endanger the remediation workers, to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected, and to provide information that will be used to design the final status survey.

The staff will review the final status survey design to determine whether the survey design is adequate for demonstrating compliance with the radiological criteria for license termination.

The staff will review the results of the final status survey to determine whether the survey demonstrates that the site, area, or building meets the radiological criteria for license termination.

Note to the NRC staff: NRC regulations require that decommissioning plans include a description of the planned final radiological survey. However, the Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM) approach requires that certain information needed to develop the final radiological survey be developed as part of the remedial activities at the site. As such, a complete description of the planned final radiological survey may not be available at the time the licensee or responsible party submits the decommissioning plan.

Therefore, licensees or responsible parties may submit information on facility radiation surveys in one of two ways, as summarized below:

- Method 1

  Licensees or responsible parties may submit the information contained in sections 14.1-14.3 of this SRP Module as part of the decommissioning plan, along with a commitment to use the MARSSIM approach in developing the final radiological survey. Information in section 14.4 would then be submitted by the licensee or responsible party at the completion of remediation or when the licensee or responsible party has completed developing the design of the final radiological survey for the site. The Final Status Survey Report (section 14.5) will be submitted after the licensee or responsible party has performed the final radiological survey.

- Method 2

  Licensee or responsible party's may submit the information contained in sections 14.1-14.4 of this SRP Module along with a commitment to calculate the number of sampling points that will be used in the final radiological survey in accordance with the procedure described in MARSSIM. The Final Status Survey Report (section 14.5) would then be submitted after the licensee or responsible party has performed the final radiological survey. If this method is used, the licensee or responsible party should include the information contained in the last three bullets under "Information to be Submitted," in section 14.4 in the Final Status Survey Report.

<u>Acceptance Review</u>

The staff will ensure that the licensee's submittal contains the information summarized under "Areas of Review" above, as appropriate for the particular submittal. The staff will review the information submitted to ensure that the level of detail appears to be adequate for the staff to perform a detailed technical review, but will not review the technical adequacy of the information. The adequacy of this information will be assessed during the detailed review.

<u>Safety Evaluation</u>

The material to be reviewed is both informational in nature and requires specific detailed technical analysis. The staff will verify that the survey designs and results are adequate for demonstrating compliance with the radiological criteria for license termination.

14.1 RELEASE CRITERIA

The purpose of the staff's review of the release criteria is to verify that the licensee has summarized appropriate release criteria, referred to as the derived concentration guideline levels (DCGLs or $DCGL_W$) and the derived concentration guideline levels/elevated measurement concentration ($DCGL_{EMC}$), for all impacted media.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1402, 20.1403, and 20.1404

Regulatory Guidance

- Draft NUREG-1549, “Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination”
- NUREG-1575, “Multi-Agency Radiological Survey and Site Investigation Manual” (MARSSIM)

Information to be Submitted

The licensee should list the DCGL(s) that will be used to design the surveys and to demonstrate compliance with the radiological criteria for release, including:

- A summary table or list of the $DCGL_W$ for each radionuclide and impacted medium of concern;

- If Class 1 survey units are present, a summary table or list of area factors that will be used for determining a $DCGL_{EMC}$ for each radionuclide and media of concern;

- If Class 1 survey units are present, the $DCGL_{EMCs}$ for each radionuclide and medium of concern;

- If multiple radionuclides are present, the appropriate $DCGL_W$ for the survey method to be used.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that, for each radionuclide and impacted media of concern, the licensee has provided a $DCGL_W$ and, if Class 1 survey units are present, a table of area factors. The staff should verify that the values presented are consistent with the values developed pursuant to the dose modeling, as discussed in Section 5 of this SRP. If multiple radionuclides are present, MARSSIM Sections 4.3.2, 4.3.3, and 4.3.4 describe acceptable methods to determine DCGLs appropriate for the survey technique.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan (or the Final Status Survey Report) for the (insert facility name and license number) according to the NMSS Standard Review Plan, Section 14.1 ("Release Criteria"). Based on this review, the NRC staff have determined that (licensee name) has summarized the DCGL(s) and area factors used for survey design and for demonstrating compliance with the radiological criteria for license termination.

14.2 CHARACTERIZATION SURVEYS

The purpose of the staff's review is to verify that the licensee determined the radiological condition of the property well enough to permit planning for a remediation that will be effective and will not endanger the remediation workers, to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected, and to provide sufficient information for designing the final status survey. Note that some licensee have used, or may request authorization to use, information developed during the characterization survey to support the final radiological survey.

Generally, the type and scope of the characterization survey information are less detailed than that required for a final radiological survey. However, licensees may use characterization survey data to support the final radiological survey, as long as they can demonstrate that non-impacted areas at the site have not been adversely impacted by decommissioning operations, and the characterization survey data are of sufficient scope and detail to meet the Information to be Submitted of a final survey.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(i), 40.42(g)(4)(i), 70.38(g)(4)(i), and 72.54(g)1

Regulatory Guidance

- NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM)

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine that the characterization survey design is adequate to determine the radiological status of the facility. The licensee should describe the radiation characterization survey design and the results of the survey including:

- A description and justification of the survey measurements for impacted media (for example, building surfaces, building volumetric, surface soils, subsurface soils, surface water, groundwater, sediments, etc., as appropriate);

- Description of the field instruments and methods that were used for measuring concentrations and the sensitivities of those instruments and methods;
- A description of the laboratory instruments and methods that were used for measuring concentrations and the sensitivities of those instruments and methods;
- The survey results including tables or charts of the concentrations of residual radioactivity measured;
- Maps or drawings of the site, area, or building showing areas classified as non-impacted or impacted and visually summarizing residual radioactivity concentrations in impacted areas;
- The justification for considering areas to be non-impacted;
- A discussion of why the licensee considers the characterization survey to be adequate to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected;
- For areas and surfaces that are inaccessible or not readily accessible, a discussion of how they were surveyed or why they did not need to be surveyed;
- For sites, areas, or buildings with multiple radionuclides, a discussion justifying the ratios of radionuclides that will be assumed in the final status survey or an indication that no fixed ratio exists and each radionuclide will be measured separately (note that this information may be developed and refined during decommissioning and licensees may elect to include a plan to develop and justify final radionuclide ratios in the decommissioning plan).

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the licensee has adequately characterized the site, area, or building relative to the location and extent of residual radioactivity. An adequate characterization is one which permits planning for a remediation that will be effective and will not endanger the remediation workers, demonstrates that it is unlikely that significant quantities of residual radioactivity have gone undetected, and provides information that will be used to design the final status survey. The extent of detail in the information provided by the licensee should be appropriate for the specific site, area, or building.

The staff should verify that the characterization survey design and results demonstrate that the licensee or responsible party has adequately characterized the site. The characterization survey is adequate if it meets the criteria in:

- Section 5.3 of MARSSIM for characterization survey (staff may use the Example Characterization Survey Checklist in Section 5.3 of MARSSIM for evaluating the licensee's submittal);

- MARSSIM Chapter 6 and Appendix E for instrument capabilities and sensitivities;

- MARSSIM Section 4.8.4 for the preparation of areas for surveys.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan (or Final Status Survey Report) for the (insert facility name and license number) according to the NMSS Standard Review Plan, Section 14.2 ("Characterization Surveys"). This review has determined that the radiological characterization of the site, area, or building is adequate to permit planning for a remediation that will be effective and will not endanger the remediation workers, to demonstrate that it is unlikely that significant quantities of residual radioactivity has not gone undetected, and to provide information that will be used to design the final status survey.

14.3 REMEDIAL ACTION SUPPORT SURVEYS

The purpose of the review of the description of the remedial action support surveys is to verify that the licensee has designed these surveys appropriately and will assist the licensee in determining when remedial actions have been successful and the final status survey may commence. In addition, information from these surveys may be used to provide the principal estimate of contaminant variability that will be used to calculate the final status survey sample size in a remediated survey unit.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), and 70.38(g)(4)(ii),

Regulatory Guidance

- NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM)

Information to be Submitted

The staff shall verify that the following information is included in the licensee's or responsible party's description of the support survey documentation:

- A description of field screening methods and instrumentation; and

- A demonstration that field screening should be capable of detecting residual radioactivity at the DCGL.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the description of the remedial action support surveys meets the criteria in MARSSIM Chapter 5.4 for the approach to be followed in performing remedial action support surveys and the criteria in the applicable MARSSIM chapters listed in this SRP for the evaluation of technical issues, such as appropriate surveys instruments, survey instrument sensitivity, etc.

Sample Evaluation Findings

None. Facility surveys in support of decommissioning are an iterative process where each survey builds on the data that will be used in the final status survey design. The staff should combine the findings from section 14.3 with those from sections 14.1 and 14.2.

14.4 FINAL STATUS SURVEY DESIGN

The purpose of the staff's review is to verify that the design of the final status survey is adequate to demonstrate compliance with the radiological criteria for license termination.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1501(a), 30.36(g)(4)(iv), 40.42(g)(4)(iv), 70.38(g)(4)(iv), and 72.54(g)4

Regulatory Guidance

- Draft NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys"
- NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM)
- NUREG-1507, "Minimum Detectable Concentrations with Typical Survey Instruments for Various Contaminants and Field Conditions"

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine that the final status survey design is adequate to demonstrate compliance with the radiological criteria for license termination. The information should include:

- A brief overview describing the final status survey design;
- A description and map or drawing of impacted areas of the site, area, or building classified by residual radioactivity levels (Class 1, Class 2, or Class 3) and divided into survey units, with an explanation of the basis for division into survey units. Maps should have compass headings indicated;
- A description of the background reference areas and materials, if they will be used, and a justification for their selection;
- A summary of the statistical tests that will be used to evaluate the survey results, including the elevated measurement comparison, if Class 1 survey units are present, a justification for any test methods not included in MARSSIM, and the values for the decision errors (α and β) with a justification for α values greater than 0.05;
- A description of scanning instruments, methods, calibration, operational checks, coverage, and sensitivity for each media and radionuclide;
- For in-situ sample measurements made by field instruments, a description of the instruments, calibration, operational checks, sensitivity, and sampling methods, with a demonstration that the instruments, and methods, have adequate sensitivity;
- A description of the analytical instruments for measuring samples in the laboratory, including the calibration, sensitivity, and methodology for evaluation, with a demonstration that the instruments and methods have adequate sensitivity;
- A description of how the samples to be analyzed in the laboratory will be collected, controlled, and handled;
- A description of the final status survey investigation levels and how they were determined;
- A summary of any significant additional residual radioactivity that was not accounted for during site characterization;
- A summary of direct measurement results and/or soil concentration levels in units that are comparable to the DCGL and, if data is used to estimate or update the survey unit;
- A summary of the direct measurements or sample data used to both evaluate the success of remediation and to estimate the survey unit variance.

EVALUATION FINDINGS

Evaluation Criteria

The staff's review should verify that the final status survey design is adequate to demonstrate compliance with the radiological criteria for license termination. The final status survey design is adequate if it meets the criteria in:

- MARSSIM Sections 4.4 and 4.6 for classifying areas by residual radioactivity levels and dividing areas into survey units of acceptable size;
- MARSSIM Section 4.5 for methods to select background reference areas and materials;
- NUREG-1505, Chapter 13, for a method to account for differences in background concentrations between different reference areas;
- MARSSIM Section 5.5.2 for statistical tests;
- Appendix E, Section 7.2 for decision errors;
- MARSSIM Sections 6.5.3 and 6.5.4 for selection of acceptable survey instruments, calibration, and operability check-out methods;
- MARSSIM Section 6.7 for methods to determine measurement sensitivity;
- NUREG-1507 for instrument sensitivity information;
- MARSSIM Sections 5.5.2.4, 5.5.2.5, 5.5.3, 7.5, and 7.6 for scanning and sampling
- MARSSIM Section 7.7 for sample analytical methods. Table 7.2 of Section 7.7 provides acceptable analytical procedural references;
- MARSSIM Sections 7.5 and 7.6 for methods for sample collection;
- MARSSIM Section 5.5.2.6 for survey investigation levels; and
- Appendix E, Section 10 and 11 for surveys for special structural or land situations.

Sample Evaluation Findings

The NRC staff has reviewed the information in the Decommissioning Plan (or the Final Status Survey Report) for the (insert facility name and license number) according the NMSS Standard Review Plan, Section 14.3. Based on this review, the NRC staff has determined that (licensee name) final status survey design is adequate to demonstrate compliance with radiological criteria for license termination.

14.5 FINAL STATUS SURVEY REPORT

The purpose of the staff's review is to verify that the results of the final status survey demonstrate that the site, area, or building meet the radiological criteria for license termination. For licensees who have submitted a decommissioning plan, the final status survey report need only include the information below. For licensees who have not submitted a decommissioning plan, the licensee submittal should include not only the information below, but any other relevant information requested in other parts of this standard review plan.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1402, 20.1403, 20.1501, 30.36(j)(2), 40.42(j)(2), 70.38(j)(2), and 72.54(I)(2)

Regulatory Guidance

- NUREG-1575, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM)

Information to be Submitted

The information submitted by the licensee should be sufficient to allow the staff to determine that the site, area, or building meets the radiological criteria for license termination. The information should include:

- An overview of the results of the final status survey;
- A discussion of any changes that were made in the final status survey from what was proposed in the Decommissioning Plan or other prior submittals;
- A description of the method by which the number of samples was determined for each survey unit;
- A summary of the values used to determine the numbers of sample and a justification for these values;
- The survey results for each survey unit including:
  - The number of samples taken for the survey unit;
  - A map or drawing of the survey unit showing the reference system and random start systematic sample locations for Class 1 and 2 survey units, and random locations shown for Class 3 survey units and reference areas;
  - The measured sample concentrations;
  - The statistical evaluation of the measured concentrations;

- Judgmental and miscellaneous sample data sets reported separately from the those samples collected for performing the statistical evaluation;
- A discussion of anomalous data including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of $DCGL_w$; and
- A statement that a given survey unit satisfied the $DCGL_w$ and the elevated measurement comparison if any sample points exceeded the $DCGL_w$;

- A description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity;

- If a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for final radiological surveys; and

- If a survey unit fails, a discussion of the impact that the reason for the failure has on other survey unit information.

EVALUATION FINDINGS

Evaluation Criteria

The review should verify that the Final Status Survey Report is adequate to demonstrate compliance with the radiological criteria for license termination. The staff's review should verify that the licensee's final status survey results support the conclusion that each survey unit meets the radiological criteria for license termination.   The Final Status Survey Report is adequate if it meets the criteria in:

- MARSSIM Section 5.5.2 for the acceptable numbers of samples; and,

- MARSSIM Sections 8.3, 8.4, and 8.5, for interpretations of sample results

Sample Evaluation Findings

The NRC staff has reviewed the final status survey results for (insert facility name and license number) according the NMSS Standard Review Plan, Section 14.5 ("Final Status Survey Report"). Based on this review, the NRC staff has determined that (licensee name) has demonstrated that the licensee's site (or area or building) meets the radiological criteria for license termination.

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 15.0
FINANCIAL ASSURANCE

RESPONSIBILITY FOR REVIEW

Primary:	NMSS:	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch
Secondary:	None	
Support:	Office of the General Counsel	

INTRODUCTION

This SRP module discusses the financial assurance demonstrations that must be submitted by materials licensees: (1) at the time of license application or renewal and (2) at the end of licensed operations. The module addresses the financial assurance requirements that apply when the license will be terminated for unrestricted release and when the license will be terminated under restricted conditions.

This module is primarily intended for NRC staff. Specific instructions designed for licensees, applicants, and responsible parties are provided in Appendix F.

(Note: The financial assurance demonstrations discussed below are independent of the cost-benefit analysis required as part of the demonstration that residual radioactivity has been reduced to a level that is ALARA. Guidance on preparing and reviewing the cost-benefit calculation for the ALARA analysis is contained in SRP 7.)

(Note: Throughout the remainder of this module, the term “licensee” is used generally to refer to licensees, applicants, and responsible parties.)

<u>Financial Assurance Demonstrations Required at License Application or Renewal</u>

At the time of license application or renewal, licensees that are authorized to possess nuclear materials in excess of certain thresholds specified in 10 CFR Part 30, 40, 70, or 72 must submit either a *decommissioning funding plan (DFP)* or a *certification of financial assurance* to demonstrate that sufficient funds will be available when needed for decommissioning the licensed facility.

- A DFP is based on a site-specific cost estimate for decommissioning.

- A certification of financial assurance relies on coverage levels specified in NRC regulations.

Licensees may choose among a number of different mechanisms to comply with the financial assurance requirements for decommissioning. The following financial assurance “methods” are specifically allowed under 10 CFR Parts 30, 40, 70, or 72:

- *Prepayment*. Under this method, the licensee provides advance decommissioning funding in full using an account segregated from licensee assets and outside the licensee’s administrative control. Acceptable prepayment mechanisms include trust funds, escrow accounts, government funds, certificates of deposit (CDs), and deposits of government securities.

- *Surety, insurance, or guarantee*. Under this method, an entity with adequate financial strength (e.g., a surety, bank, or insurer) guarantees that the required amount of funds will be available whenever needed. Acceptable surety, insurance, or guarantee mechanisms include surety bonds, letters of credit, lines of credit, insurance policies, parent company guarantees, and self-guarantees.

- *External sinking fund*. This method allows a licensee to gradually prepay for decommissioning by combining the use of a partially-funded prepayment instrument (e.g., a trust or escrow) with a surety bond, letter of credit, or insurance covering the unfunded balance.

- *Statement of intent*. This method is a commitment by a Federal, State, or local government licensee to request and obtain decommissioning funds from its funding body, when necessary.

Licensees may also use combinations of the above instruments, except in the case of parent company guarantees and self-guarantees, which cannot be combined with other mechanisms.

<u>Financial Assurance Demonstrations Required at the End of Licensed Operations</u>

At the end of licensed operations, licensees must maintain all financial assurance established pursuant to 10 CFR Parts 30, 40, 70, or 72. In addition, licensees must submit a *decommissioning plan* if (1) such a plan is required by a license condition, or (2) the procedures and activities necessary to carry out decommissioning (and, if applicable, site control and maintenance) have not been approved by the NRC and these procedures could increase the potential health and safety impacts to workers or the public (10 CFR 30.36, 40.42, 70.38, or 72.54).

A decommissioning plan must include "an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning." If the license is being terminated under restricted conditions, the decommissioning plan also must include estimated costs for control and maintenance of the site, along with financial assurance coverage for these costs. In addition to the cost estimate and financial assurance mechanism(s), the financial assurance demonstration in a decommissioning plan must contain a description of the means the licensee will employ for adjusting the cost estimate and associated funding level over any storage or surveillance period.

Licensees may choose among the mechanisms listed above to comply with the financial assurance requirements for decommissioning and, if applicable, for site control and maintenance. However, external sinking funds may not be used to cover costs for site control and maintenance. In addition, if the license is being terminated under restricted conditions, 10 CFR 20.1403 allows financial assurance to be provided through special arrangements with a government entity that assumes custody and ownership of the site.

AREAS OF REVIEW

The staff will evaluate the decommissioning financial assurance demonstrations submitted by licensees or license applicants pursuant to the requirements in 10 CFR Parts 30, 40, 70, and 72. The staff will evaluate the licensee's or applicant's financial assurance demonstration to ensure that sufficient funds will be available to carry out decommissioning activities and site control and maintenance (if applicable) in a safe and timely manner. This information should include:

- For a DFP: (1) a site-specific cost estimate for decommissioning, (2) a description of the means for adjusting the cost estimate and associated funding level periodically over the life of the facility, (3) a certification by the licensee that financial assurance has been provided in the amount of the cost estimate, and (4) one or more financial assurance mechanisms (including supporting documentation).

- For a certification of financial assurance: (1) a "certification statement" (which certifies that the licensee has provided financial assurance in the appropriate amount specified in 10 CFR Parts 30, 40, or 70), and (2) one or more financial assurance mechanisms (including supporting documentation).

- For a decommissioning plan, (1) an updated, detailed cost estimate for decommissioning and, if the license is being terminated under restricted conditions, for control and maintenance of the site following license termination; (2) one or more financial assurance mechanisms (including supporting documentation); (3) a comparison of the cost estimate with the present funds set aside for decommissioning and, if the license is being terminated under restricted conditions, for control and maintenance of the site following license termination; and (4) a description of the means the licensee will employ for adjusting the cost estimate and associated funding level over any storage or surveillance period.

REVIEW PROCEDURES

Acceptance Review

The staff will review the financial assurance demonstration submitted by the licensee in accordance with the procedures outlined in this module. The staff will ensure that, at a minimum, the financial assurance submission includes the information summarized under “Areas for Review,” above. In addition:

- For a licensee submitting a DFP at the time of license application or renewal, the staff will review:
  - The accuracy and appropriateness of the methods used by the licensee to estimate the costs of decommissioning;
  - The acceptability of the licensee’s submitted financial assurance mechanism(s) for decommissioning; and
  - The means identified in the DFP for adjusting the cost estimate and associated funding level over the life of the facility.
- For a licensee submitting a certification of financial assurance at the time of license application or renewal, the staff will review:
  - The certification statement, to ensure that it certifies compliance with the appropriate requirements and that it specifies the correct amount of financial assurance; and
  - The acceptability of the licensee’s submitted financial assurance mechanism(s).
- For a licensee submitting a decommissioning plan at the end of licensed operations, the staff will review:
  - The accuracy and appropriateness of the methods used by the licensee to estimate the costs of decommissioning and, if the license is being terminated under restricted conditions, the costs of site control and maintenance;
  - The acceptability of the licensee’s submitted financial assurance mechanism(s) for decommissioning and, if the license is being terminated under restricted conditions, for site control and maintenance; and

- The means identified in the decommissioning plan for adjusting the cost estimate and associated funding level over any storage or surveillance period.

Safety Evaluation

The material to be reviewed by the staff is technical in nature. The staff will make a quantitative evaluation of the licensee's or responsible party's (1) cost estimate or certification amount, and (2) financial assurance mechanism(s).

15.1 COST ESTIMATE (as contained in a DFP or DECOMMISSIONING PLAN)

The purpose of the review of the cost estimate is to ensure that the licensee or responsible party has developed a cost estimate for decommissioning the facility based on documented and reasonable assumptions and that the estimated cost is sufficient to allow an independent third party to assume responsibility for decommissioning the facility if the licensee or responsible party is unable to complete the decommissioning. In addition, if the licensee or responsible party intends to request license termination under restricted conditions, the cost estimate should be sufficient to allow an independent third party to assume responsibility for all necessary control and maintenance activities at the site.

Regulatory Requirements

- 10 CFR 20.1403(c), 20.1403(e)(2)(iii), 30.35(e), 30.36(e), 30.36(g)(4)(v), 10 CFR 40.36(d), 40.42(e), 40.42(g)(4)(v), 70.25(e), 70.38(e), 70.38(g)(4)(v), 72.30(b), 72.54(e), and 72.54(g)(5)

Regulatory Guidance

- Appendix F to this SRP
- NUREG/CR-6477, "Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities"
- NUREG/CR-0129, "Technology, Safety and Costs of Decommissioning a Reference Small Mixed Oxide Fuel Fabrication Plant"
- NUREG/CR-1266, "Technology, Safety and Costs of Decommissioning a Reference Uranium Fuel Fabrication Plant"
- NUREG/CR-1757, "Technology, Safety and Costs of Decommissioning a Reference Uranium Hexafluoride Conversion Plant"
- NUREG/CR-2210, "Technology, Safety and Costs of Decommissioning a Reference Independent Spent Fuel Storage Installation"
- NUREG/CR-2241, "Technology and Costs of Termination Surveys Associated with Decommissioning of Nuclear Facilities"
- NUREG/CR-3293, "Technology, Safety and Costs of Decommissioning Reference Nuclear Fuel Cycle and Non Fuel Cycle Facilities Following Postulated Accidents"
- NUREG/CR-6174, "Revised Analyses of Decommissioning for the Reference Boiling Water Reactor Power Station," Volumes 1 and 2

- NUREG/CR-5884, “Revised Analyses of Decommissioning for the Reference Pressurized Water Reactor Power Station,” Volumes 1 and 2
- NUREG/CR-6270, “Estimating Boiling Water Reactor Decommissioning Costs”
- NUREG/CR-6054, “Estimating Pressurized Water Reactor Decommissioning Costs”
- NUREG/CR-1307, “Report on Waste Burial Charges,” Revision 5
- NUREG/CR-6280, “Technology, Safety, and Costs of Decommissioning a Reference Large Irradiator and Reference Sealed Sources”
- NUREG/CR-6477, “Revised Analysis of Decommissioning Reference Non-Fuel-Cycle Facilities.”

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to determine if the cost estimates for decommissioning and site control and maintenance (if applicable) are reasonable, and were developed in accordance with NRC regulations and guidance. The staff’s review should verify that the cost estimates for decommissioning and site control and maintenance incorporate all of the information summarized under “Evaluation Criteria,” below.

Sections 3 and 18 of Appendix F to this SRP contain guidance -- including cost estimating tables -- to assist licensees in preparing cost estimates that will be acceptable to the NRC. The staff should use this guidance to the extent necessary in reviewing costs estimates submitted by licensees.

In addition, specific guidelines on the review process for cost estimates are included in Appendix G to this SRP.

Evaluation Criteria

The information supplied by the licensee or responsible party should be sufficient to allow the staff to determine if the licensee’s cost estimate(s) is adequate by comparing the information presented in the DFP or decommissioning plan with applicable NRC regulations and guidance. A cost estimate for decommissioning and site control and maintenance (if applicable) is acceptable if it meets all of the conditions in Sections 15.1.1 and 15.1.2.

15.1.1 Evaluation Criteria Applicable to All Cost Estimates for Unrestricted or Restricted Release

- The cost estimate meets the applicable regulatory requirements in 10 CFR 20.1403(c), 20.1403(e)(2)(iii), 30.35(e), 30.36(e), 30.36(g)(4)(v), 40.36(d), 40.42(e), 40.42(g)(4)(v), 70.25(e), 70.38(e), 70.38(g)(4)(v), 72.30(b), 10 CFR 72.54(e), and 72.54(g)(5);
- The cost estimate is based on documented and reasonable assumptions;
- The unit cost factors used in the cost estimate are reasonable and consistent with NRC cost estimation reference documents;

- The cost estimate includes costs for labor, equipment and supplies, overhead and contractor profit, sampling and laboratory analysis, and miscellaneous expenses (e.g., license fees, insurance, and taxes);

- The cost estimate applies a contingency factor of at least 25 percent to the sum of all estimated costs;

- The cost estimate does not take credit for: (1) any salvage value that might be realized from the sale of potential assets during or after decommissioning, or (2) reduced taxes that might result from payment of decommissioning costs or site control and maintenance costs;

- The means identified in the DFP or decommissioning plan for adjusting the cost estimate and associated funding level over the life of the facility and any storage or surveillance period is adequate;

- The cost estimate reflects decommissioning under appropriate facility conditions (for a DFP, routine facility conditions should be assumed; for a decommissioning plan, facility conditions at the end of licensed operations should be assumed); and

- The cost estimate includes costs for all major decommissioning and site control and maintenance activities specified in Sections 3 and 18 of Appendix F to this SRP, including (1) planning and preparation, (2) decontamination and/or dismantling of facility components, (3) packaging, shipment, and disposal of radioactive wastes, (4) a final radiation survey, (5) restoration of contaminated areas on facility grounds (if necessary), and (6) site stabilization and long-term surveillance (if necessary).

15.1.2 Additional Evaluation Criteria Applicable to Cost Estimates for Restricted Release

- The cost estimate for site control and maintenance is consistent with the amount of radioactivity remaining at the site, the radionuclides involved, the characteristics of the residual radioactivity at the site, and site-specific exposure scenarios, pathways, and parameters;

- The cost estimate for site control and maintenance includes all costs for enforcement of institutional controls, including activities related to physical barriers at the site (e.g., periodic inspection, surveys, control, maintenance) and maintenance/monitoring of deed restrictions or other institutional controls (if applicable);

- The cost estimate for site control and maintenance accounts for the costs of establishing and implementing institutional controls, recordkeeping related to the controls, and corrective actions;

- The cost estimate for site maintenance includes adequate periods of site control and accounts for all associated costs during this period;

- The cost estimate for site control and maintenance assumes that all activities will be carried out to a level sufficient to prevent the annual dose to the average member of the critical group from exceeding 0.25 mSv (25 mrem); and

- The cost estimate for site control and maintenance accounts for periodic checks and inspections of the site no less frequently than every 5 years by the party responsible for site control and maintenance (if applicable).

Sample Evaluation Findings

The NRC staff has reviewed the cost estimate for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 15 (Financial Assurance for Decommissioning). Based on this review, the NRC staff has determined that the cost estimate submitted by the licensee adequately reflects the costs to carry out all required decommissioning activities prior to license termination and, if the license is being terminated under restricted conditions, to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site.

(Note: Appendix H to this SRP contains a sample post-review letter from the NRC to licensees for cases where no deficiencies are found in the submittal.)

15.2 CERTIFICATION STATEMENT

(Note: This section applies only to reviews of submissions that demonstrate financial assurance using one or more of the three certification amounts [$75,000, $150,000, or $750,000] prescribed in 10 CFR Parts 30, 40, and 70.)

The purpose of the review of the certification statement is to ensure that, based on the licensed possession limits and the applicable quantities specified in 10 CFR 30.35, 40.36, or 70.25, the licensee is eligible to use a certification of financial assurance and, if eligible, that the certification amount is appropriate.

Regulatory Requirements

- 10 CFR 30.35(d), 40.36(b) and (c), and 70.25(d)

Regulatory Guidance

- Appendix F to this SRP

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to determine if the certification statement was developed in accordance with NRC regulations and guidance. The staff's review should verify that the certification statement satisfies all of the information summarized under "Evaluation Criteria," below.

In determining whether use of a certification of financial assurance is allowable and whether the certification amount is appropriate, the staff should use the method outlined in 10 CFR 30.35, 40.36, and 70.25. Additional guidance on this method is contained in Section 2 of Appendix F to this SRP. Appendix F also contains a table showing (for each isotope with a half-life greater than 120 days) the activity levels for which certifications of financial assurance are allowed under NRC regulations. The table also shows the certification amounts that are applicable to specific activity levels for each isotope.

The worksheet below can be used to help determine the total certification amount required for one or more licenses. In completing the worksheet, the required certification amounts under all applicable parts of 10 CFR (i.e., 30, 40, and 70) should be entered on the appropriate lines and added to yield the total required certification amount.

Section 2 of Appendix F to this SRP contains guidance -- including recommended wording and checklists -- to assist licensees in preparing certification statements that will be acceptable to NRC. The staff should use this guidance to the extent necessary in reviewing certification statements submitted by licensees.

In addition, specific guidelines on the review process for certification statements are included in Appendix G to this SRP.

<u>Evaluation Criteria</u>

The information supplied by the licensee should be sufficient to allow the staff to determine if the licensee's certification statement is adequate by comparing it with applicable NRC regulations and guidance. A certification statement is acceptable if it meets <u>all</u> of the following conditions:

- Use of a certification is allowed based on the licensed possession limits and the applicable quantities specified in 10 CFR 30.35, 40.36, or 70.25;

- The certification amount is appropriate based on the licensed possession limits and the applicable quantities specified in 10 CFR 30.35, 40.36, or 70.25; and

- The certification statement includes all necessary information, including the name of the licensee, the locations of the facilities for which financial assurance is provided, the amount and types of materials authorized for possession under the license, and the certification amount(s).

WORKSHEET FOR DETERMINING THE REQUIRED CERTIFICATION AMOUNT

Applicable Part of 10 CFR (check all that apply): ☐ Part 30 ☐ Part 40 ☐ Part 70 ☐ Part 72*

	Required Certification Amount ($)
Part 30 (sealed sources):	____________
Part 30 (unsealed sources):	____________
Part 40:	____________
Part 70:	____________
Total of all certification amounts for all licenses:	____________

*Certifications of financial assurance do not apply to Part 72 licenses.

Sample Evaluation Findings

The NRC staff has reviewed the certification statement for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 15 (Financial Assurance for Decommissioning). Based on this review, the NRC staff has determined that the certification statement submitted by the licensee specifies the appropriate information and level of financial assurance coverage.

(Note: Appendix H to this SRP contains a sample post-review letter from the NRC to licensees for cases where no deficiencies are found in the submittal.)

15.3 FINANCIAL ASSURANCE MECHANISM

The purpose of the review of the licensee's financial assurance mechanism is to ensure that sufficient funds will be available to carry out all required decommissioning activities prior to license termination and, if the license is being terminated under restricted conditions, to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site.

Regulatory Requirements

- 10 CFR 20.1403(c), 20.1403(e)(2)(iii), 30.35(f), 30.36(e), 40.36(e), 40.42(e), 70.25(f), 70.38(e), 72.30(c), and 72.54(e)

Regulatory Guidance

- Appendix F to this SRP
- NUREG/BR-0241, “NMSS Handbook for Decommissioning Fuel Cycle and Materials Licensees.”

Information Requirements

The financial assurance mechanism supplied by the licensee or responsible party shall consist of one or more of the following instruments:

- Trust fund;
- Escrow account;
- Government fund;
- Certificate of deposit (CD);
- Deposit of government securities;
- Surety bond;
- Letter of credit;
- Line of credit;
- Insurance policy;
- Parent company guarantee;
- Self-guarantee;
- External sinking fund;
- Statement of intent; or
- Special arrangements with a government entity that assumes custody and ownership of the site.

(Note: For decommissioning plans, external sinking funds may not be used to cover costs for site control and maintenance. Special arrangements with a government entity that assumes custody and ownership of the site may be used only if the license is being terminated under restricted conditions.)

The staff’s review should verify that the financial assurance mechanism for decommissioning and site maintenance and control meets the criteria summarized under “Evaluation Criteria,” below.

Sections 4 through 18 of Appendix F to this SRP contain guidance -- including recommended wording and checklists -- to assist licensees in preparing financial mechanisms that will be acceptable to NRC. The staff should use this guidance to the extent necessary in reviewing financial mechanisms submitted by licensees.

In addition, specific guidelines on the review process for financial mechanisms are included in Appendix G to this SRP.

Evaluation Criteria

The staff should verify that the financial assurance mechanism supplied by the licensee or responsible party meets the general requirements for all financial assurance mechanisms listed in Sections 15.3.1 and 15.3.2 and the applicable specific requirements listed in Section 15.3.3.

15.3.1 Evaluation Criteria Applicable to All Financial Assurance Mechanisms for Unrestricted or Restricted Release

- The financial assurance mechanism is an originally signed duplicate; and

- The wording of the financial assurance mechanism is identical to the recommended wording provided in the applicable section of Appendix F to this SRP (if the wording is not identical to the recommended wording, the staff will follow the procedures outlined in Appendix G to this SRP).

15.3.2 Additional Evaluation Criteria Applicable to All Financial Assurance Mechanisms for Restricted Release

- None (additional evaluation criteria applicable to specific financial assurance mechanisms for restricted release are listed below).

15.3.3 Evaluation Criteria for Specific Financial Assurance Mechanisms (Unrestricted and Restricted Release)

15.3.3.1 Trust Funds

In addition to the evaluation criteria outlined in Section 15.3.1 above, a trust fund submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Trust agreement
  - Schedule A
  - Schedule B
  - Schedule C
  - Specimen certificate of events
  - Specimen certificate of resolution
  - Letter of acknowledgment
  - Receipt or statement from the trustee showing the trust’s current market value

- The trustee is an appropriate State or Federal government agency or a financial institution that has the authority to act as trustee and whose trust operations are regulated and examined by a Federal or State agency. If evidence of the trustee’s qualifications is not provided in the submission, the reviewer will evaluate the trustee’s qualifications as follows:

- The word “National” in the title of a financial institution signals that the institution is *Federally regulated*, as do the words “National Association” or the initials “N.A.” following its title. To determine whether such a financial institution qualifies as an acceptable trustee, the reviewer will access the Federal Financial Institutions Examination Council’s (FFIEC) Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

  Alternatively, the reviewer may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution (1) is Federally regulated <u>and</u> (2) has Federally regulated trust operations. (The OCC’s home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

  - <u>Northeastern District Office</u> (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

  - <u>Southeastern District Office</u> (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

  - <u>Central District Office</u> (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

  - <u>Midwestern District Office</u> (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

  - <u>Southwestern District Office</u> (214-720-0656) -- AR, LA, OK, and TX.

  - <u>Western District Office</u> (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

- The word “State” in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable trustee, the reviewer will access the FFIEC’s Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

Alternatively, the reviewer may contact the applicable State banking authority and confirm that the institution (1) is State regulated, and (2) has State-regulated trust operations. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated. This is also often true in the case of domestic branches of foreign banks.

- The licensee has not assumed any real rate of return on funds in the trust that apply to decommissioning;
- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds in the trust that apply to site control and maintenance;
- Under the appropriate assumptions regarding earnings on the trust, the current market value of the trust is sufficient to pay for all required activities. Exception: If the trust is being used in combination with another financial assurance mechanism(s), the value of the trust (accounting for earnings on pre-paid funds for site control and maintenance activities, if applicable) must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s);
- The maximum withdrawal of funds at one time for a particular activity (i.e., decommissioning or site control/maintenance) is limited to 10 percent of the remaining funds available for that activity unless approval from the appropriate party (i.e., the NRC or the party responsible for site control and maintenance) is attached; and
- Schedule A to the trust agreement allows the trustee to access the full amount of coverage (using multiple withdrawals as necessary) to conduct all decommissioning and/or site control and maintenance activities. The amount shown in Schedule A must be at least as great as the licensee's cost estimate or certification amount.

15.3.3.2 Escrow Accounts

In addition to the evaluation criteria outlined in Section 15.3.1 above, an escrow account submission must meet the following *additional* criteria:

- The following items have been included in the submission:
  - Escrow agreement
  - Specimen certificate of events
  - Specimen certificate of resolution to commence decommissioning

- Certified resolution authorizing the making and performance of the escrow agreement
- Certificate of names and specimen signatures
- Receipt or statement from the escrow agent showing the escrow's current market value

- The escrow agent is a financial institution whose operations are regulated and examined by a Federal or State agency. If evidence of the escrow agent's qualifications is not provided in the submission, the staff will evaluate the escrow agent's qualifications as follows:

  - The word "National" in the title of a financial institution signals that the institution is *Federally regulated*, as do the words "National Association" or the initials "N.A." following its title. To determine whether such a financial institution qualifies as an acceptable escrow agent, the reviewer will access the Federal Deposit Insurance Corporation's (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/.

    Alternatively, the reviewer may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC)and confirm that the institution is Federally regulated. (The OCC's home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

    - Northeastern District Office (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

    - Southeastern District Office (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

    - Central District Office (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

    - Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

    - Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

    - Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

- The word “State” in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable escrow agent, the reviewer will access the FDIC’s Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, the reviewer may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated. This is also often true in the case of domestic branches of foreign banks.

- The licensee has not assumed any real rate of return on funds in the escrow that apply to decommissioning;

- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds in the escrow that apply to site control and maintenance;

- Under the appropriate assumptions regarding earnings on the escrow, the current market value of the escrow is sufficient to pay for all required activities. Exception: If the escrow is being used in combination with another financial assurance mechanism(s), the value of the escrow (accounting for earnings on pre-paid funds for site control and maintenance activities, if applicable) must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- The maximum withdrawal of funds at one time for a particular activity (i.e., decommissioning or site control/maintenance) is limited to 10 percent of the remaining funds available for that activity unless approval from the appropriate party (i.e., NRC or the party responsible for site control and maintenance) is attached.

15.3.3.3 Government Funds

In addition to the evaluation criteria outlined in Section 15.3.1 above, a government fund submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Either:
    - Trust agreement and all supporting documentation; or

  - Escrow agreement and all supporting documentation
- List of assets deposited with the State or State agency
- Specification of the current market value of the assets deposited
- Specification of the date on which assets were transferred to the fund or account
- Specification of the licensee's certification amount or estimated cost of decommissioning (and, if applicable, site control and maintenance)
- Letter from the State or State agency stating that use of funds will be restricted to covering the costs of decommissioning (and, if applicable, site control and maintenance) on the licensee's default

- The State or State agency holding the assets in the government fund has the authority to establish special segregated funds or accounts to receive and hold funds for specified purposes (e.g., decommissioning, site control and maintenance);

- The government fund is in the form of a trust, escrow, or other arrangement acceptable to the State or State agency administering the fund;

- The licensee has not assumed any real rate of return on funds, in the government fund, that apply to decommissioning;

- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds, in the government fund, that apply to site control and maintenance;

- Under the appropriate assumptions regarding earnings on the government fund, the current market value of the fund is sufficient to pay for all required activities. Exception: If the government fund is being used in combination with another financial assurance mechanism(s), the value of the fund (accounting for earnings on pre-paid funds for site control and maintenance activities, if applicable) must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s);
- The maximum withdrawal of funds at one time for a particular activity (i.e., decommissioning or site control/maintenance) is limited to 10 percent of the remaining funds available for that activity unless approval from the appropriate party (i.e., the NRC or the party responsible for site control and maintenance) is attached; and

- If the government fund is in the form of a trust, Schedule A to the trust agreement allows the trustee to access the full amount of coverage (using multiple withdrawals as necessary) to conduct all decommissioning and/or site control and maintenance activities. The amount shown in Schedule A must be at least as great as the licensee's cost estimate or certification amount.

15.3.3.4 Certificates of Deposit (CDs)

In addition to the evaluation criteria outlined in Section 15.3.1 above, a certificate of deposit submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Certificate of deposit
  - Either:
    - Trust agreement and all supporting documentation
      or
    - Escrow agreement and all supporting documentation
      or
    - Government fund and all supporting documentation
  - Specification of the current market value of the CD
  - Specification of the date on which the CD was transferred to the fund or account
  - Specification of the licensee's certification amount or estimated cost of decommissioning (and, if applicable, site control and maintenance)
  - Verification that the CD has been placed into the trust fund, escrow account, or government fund
  - Letter from State or State agency stating that use of funds will be restricted to covering the costs of decommissioning (and, if applicable, site control and maintenance) upon the licensee's default (needed *only* if a government fund is established to hold the CD)

- The financial institution issuing the certificate of deposit is insured by the Federal Deposit Insurance Corporation (FDIC). If evidence of the financial institution's qualifications is not provided in the submission, the reviewer will verify the qualifications of the financial institution by accessing the FDIC's Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/, or by contacting the FDIC directly.

- Each certificate of deposit submitted by the licensee is in an amount no greater than $100,000 (i.e., the FDIC insurance limit);

- The licensee has deposited the certificate(s) of deposit into a trust fund, escrow account, or government fund that meets all applicable NRC requirements, as discussed in Sections 15.3.3.1, 15.3.3.2, and 15.3.3.3;

- The licensee has not assumed any real rate of return on funds in the CD that apply to decommissioning;

- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds in the CD that apply to site control and maintenance; and

- Under the appropriate assumptions regarding earnings on the CD, the current market value of the CD is sufficient to pay for all required activities. Exception: If the CD is being used in combination with another financial assurance mechanism(s), the value of the CD (accounting for earnings on pre-paid funds for site control and maintenance activities, if applicable) must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s).

15.3.3.5 Deposits of Government Securities

In addition to the evaluation criteria outlined in Section 15.3.1 above, a deposit of government securities submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Either:
    - Trust agreement and all supporting documentation
      or
    - Escrow agreement and all supporting documentation
      or
    - Government fund and all supporting documentation
  - List of securities deposited with the trustee, escrow agent, or State or State agency:
    - U.S. Treasury bills
    - U.S. Treasury notes
    - U.S. Treasury bonds
    - Government National Mortgage Association pass-through certificates (GNMAs)
    - Federal National Mortgage Association bonds (FNMAs)
    - Federal Home Loan Mortgage Corporation (FHLM) bonds
    - State or municipal bonds rated BBB or higher by Standard & Poor's, or Baa or higher by Moody's Investment Services
  - Specification of the current market value of the securities deposited
  - Specification of the date on which securities were transferred to the fund or account
  - Specification of the licensee's certification amount or estimated cost of decommissioning (and, if applicable, site control and maintenance)
  - Letter from the State or State agency stating that use of funds will be restricted to covering the costs of decommissioning (and, if applicable, site control and maintenance) upon the licensee's default (needed *only* if a government fund is established to hold securities)

- The securities used in a deposit of government securities are backed by the Federal government or a State or local government;

- The licensee has deposited the government securities into a trust fund, escrow account, or government fund that meets all applicable NRC requirements, as discussed in Sections 15.3.3.1, 15.3.3.2, and 15.3.3.3;

- The licensee has not assumed any real rate of return on funds in the deposit of government securities that apply to decommissioning;

- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds in the deposit of government securities that apply to site control and maintenance; and

- Under the appropriate assumptions regarding earnings on the deposit of government securities, the current market value of the deposit is sufficient to pay for all required activities. Exception: If the deposit of government securities is being used in combination with another financial assurance mechanism(s), the value of the deposit (accounting for earnings on pre-paid funds for site control and maintenance activities, if applicable) must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s).

15.3.3.6 Surety Bonds

In addition to the evaluation criteria outlined in Section 15.3.1 above, a surety bond submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Surety bond
  - Standby trust agreement and all supporting documentation (see Section 15.3.3.15)
  - Copy of broker/agent's power of attorney authorizing the broker/agent to issue bonds

- The surety company issuing the surety bond is listed in the most recent edition of the U.S. Department of the Treasury's *Circular 570* for the State where the surety bond was signed, and has an underwriting limitation greater than or equal to the level of coverage specified in the bond. If evidence of the surety company's qualifications is not provided in the submission, the reviewer will consult the most recent edition of *Circular 570*, which is published annually on approximately July 1 and is updated periodically in the *Federal Register*. (*Circular 570* can also be found on the World Wide Web at http://www.fms.treas.gov/c570/index.html.)

- The surety bond is payable to a standby trust fund that meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The broker/agent's power of attorney authorizes the broker or agent to issue bonds on behalf of the surety company;

- The surety bond is in an amount that is at least as great as the licensee's cost estimate or certification amount -- unless the surety bond is being used in combination with another financial assurance mechanism(s), in which case the amount of the surety bond must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a surety bond) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.7 Letters of Credit

In addition to the evaluation criteria outlined in Section 15.3.1 above, a letter of credit submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Letter of credit
  - Standby trust agreement and all supporting documentation (see Section 15.3.3.15)

- The bank issuing the letter of credit is a financial institution whose operations are regulated and examined by a Federal or State agency. If evidence of the issuer's qualifications is not provided in the submission, the reviewer will verify the qualifications of the issuer as follows:

  - The word "National" in the title of a financial institution signals that the institution is *Federally regulated*, as do the words "National Association" or the initials "N.A." following its title. To determine whether such a financial institution qualifies as an acceptable issuer of a letter of credit, the reviewer will access the Federal Deposit Insurance Corporation's (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/.

    Alternatively, the reviewer may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution is Federally regulated. (The OCC's home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

    - <u>Northeastern District Office</u> (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

    - <u>Southeastern District Office</u> (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

    - <u>Central District Office</u> (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

    - Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

    - Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

    - Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

  - The word “State” in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable issuer of a letter of credit, the reviewer will access the FDIC’s Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, the reviewer may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

  - The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated. This is also often true in the case of domestic branches of foreign banks.

- The letter of credit is payable to a standby trust fund that meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The letter of credit is in an amount that is at least as great as the licensee’s cost estimate or certification amount -- unless the letter of credit is being used in combination with another financial assurance mechanism(s), in which case the amount of the letter of credit must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a letter of credit) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.8 Lines of Credit

In addition to the evaluation criteria outlined in Section 15.3.1 above, a line of credit submission must meet the following *additional* criteria:

- The following items have been included in the submission:

- Line of credit documentation/verification
- Standby trust agreement and all supporting documentation (see Section 15.3.3.15)

- The bank issuing the line of credit is a financial institution whose operations are regulated and examined by a Federal or State agency. If evidence of the issuer's qualifications is not provided in the submission, the reviewer will verify the qualifications of the issuer as follows:

  - The word "National" in the title of a financial institution signals that the institution is *Federally regulated*, as do the words "National Association" or the initials "N.A." following its title. To determine whether such a financial institution qualifies as an acceptable issuer of a line of credit, the reviewer will access the Federal Deposit Insurance Corporation's (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/.

    Alternatively, the reviewer may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution is Federally regulated. (The OCC's home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

    - <u>Northeastern District Office</u> (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

    - <u>Southeastern District Office</u> (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

    - <u>Central District Office</u> (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

    - <u>Midwestern District Office</u> (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

    - <u>Southwestern District Office</u> (214-720-0656) -- AR, LA, OK, and TX.

    - <u>Western District Office</u> (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

  - The word "State" in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable issuer of a line of credit, the reviewer will access the FDIC's Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, the reviewer may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated. This is also often true in the case of domestic branches of foreign banks.

- The line of credit is payable to a standby trust fund that meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The licensee has obtained a written commitment from the issuer to provide funds without reservation as necessary for decommissioning and, if applicable, for site control and maintenance;

- The line of credit is in an amount that is at least as great as the licensee's cost estimate or certification amount -- unless the line of credit is being used in combination with another financial assurance mechanism(s), in which case the amount of the line of credit must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a line of credit) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.9 Insurance Policies

In addition to the evaluation criteria outlined in Section 15.3.1 above, an insurance policy submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Insurance policy
  - Standby trust agreement and all supporting documentation (see Section 15.3.3.15).

- The insurer is licensed by a State regulatory authority to transact business as an insurer in one or more U.S. States. If evidence of the insurer's qualifications is not provided in the submission, the staff will contact the State insurance commission for the State in which the insurer is located, or the National Association of Insurance Commissioners (NAIC) at (816) 842-3600 or www.naic.org, and confirm that the insurer is licensed by a State regulatory authority to transact business as an insurer in one or more U.S. States.

- The insurance policy is payable to a standby trust fund that meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The insurance policy provides coverage in an amount that is at least as great as the licensee's cost estimate or certification amount -- unless the insurance policy is being used in combination with another financial assurance mechanism(s), in which case the amount of the insurance must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- No credit is taken for earnings on any financial assurance mechanism (e.g., an insurance policy) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.10 Parent Company Guarantees

In addition to the evaluation criteria outlined in Section 15.3.1 above, a parent company guarantee submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Parent company (corporate) guarantee agreement
  - Letter from chief executive officer (CEO) of licensee
  - Letter from chief financial officer (CFO) of parent company, including parent company guarantee financial test (Alternative I or II)
  - Auditor's special report confirming CFO letter and reconciling amounts in the CFO letter with parent company's financial statements
  - Parent company's audited financial statements for the most recent fiscal year, including the auditor's opinion on the financial statements
  - Standby trust agreement and all supporting documentation (optional, but recommended) (see Section 15.3.3.15)

- The parent company guarantor has majority control of the licensee's voting stock (at least 50 percent), although the NRC may consider exceptions to this rule on a case-by-case basis. Evidence might include the guarantor's most recent Form SEC 10K (Exhibit 22) or a certified corporate resolution certifying the direct parent relationship;

- The parent company guarantor meets one of the two financial tests specified in Appendix A to 10 CFR Part 30. Furthermore, the guarantor passes the financial test for all costs covered by a financial test, including (1) the parent company guarantee, (2) other NRC or Agreement State parent company guarantees or self-guarantees, and (3) parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA);

- The parent company guarantor's annual financial statements have received a "clean" opinion from an independent certified public accountant. The accountant's opinion must state that the financial statements fairly and unconditionally present the firm's financial condition in accordance with generally accepted accounting principles. If an accountant's opinion is an adverse opinion, a disclaimer of opinion, or an opinion that raises "going concern" issues, the staff will not allow the use of a parent company guarantee. The staff will evaluate other types of accountant's opinions on a case-by-case basis in the context of the guarantor's financial statements so that the reviewer can determine the implications for the accuracy of the financial test. If the staff cannot make a decision because the information in the opinion or the financial statements is insufficient, it will require that the guarantor submit additional information. If the matter is still unresolved, the staff will request assistance from its legal counsel. If there is any doubt about the qualifications of the guarantor's independent certified public accountant, the staff will verify the accountant's credentials by contacting the State Board of Accountancy in the accountant's State;

- The parent company guarantee is not being used in combination with another mechanism to provide financial assurance for decommissioning and/or site control and maintenance;

- If the licensee submits a standby trust fund (optional) with the parent company guarantee, the standby trust fund meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The parent company guarantee is in an amount that is at least as great as the licensee's cost estimate or certification amount; and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a parent company guarantee) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.11 Self-Guarantees

In addition to the evaluation criteria outlined in Section 15.3.1 above, a self-guarantee submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Self-guarantee agreement
  - Letter from chief executive officer (CEO) or chief financial officer (CFO) of licensee, including applicable self-guarantee financial test
  - Auditor's special report confirming CEO or CFO letter and reconciling amounts in the CEO or CFO letter with licensee's financial statements

- Licensee's audited financial statements for the most recent fiscal year, including the auditor's opinion on the financial statements.

- The licensee does not have a parent company holding majority control of its voting stock (at least 50 percent);

- The licensee meets the applicable financial test specified in Appendix C, D or E to 10 CFR Part 30. Furthermore, the licensee passes the financial test for all costs covered by a financial test, including: (1) the self-guarantee, (2) other NRC or Agreement State parent company guarantees or self-guarantees, and (3) parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., the EPA);

- The licensee's annual financial statements have received a "clean" opinion from an independent certified public accountant. The accountant's opinion must state that the financial statements fairly and unconditionally present the firm's financial condition in accordance with generally accepted accounting principles. If an accountant's opinion is an adverse opinion, a disclaimer of opinion, or an opinion that raises "going concern" issues, the staff will not allow the use of a self-guarantee. The staff will evaluate other types of accountant's opinions on a case-by-case basis in the context of the licensee's financial statements so that the reviewer can determine the implications for the accuracy of the financial test. If the staff cannot make a decision because the information in the opinion or the financial statements is insufficient, it will require that the licensee submit additional information. If the matter is still unresolved, the staff will request assistance from its legal counsel. If there is any doubt about the qualifications of the licensee's independent certified public accountant, the staff will verify the accountant's credentials by contacting the State Board of Accountancy in the accountant's State;

- The self-guarantee is not being used in combination with another mechanism to provide financial assurance for decommissioning and/or site control and maintenance;

- If the licensee submits a standby trust fund (optional) with the self-guarantee, the standby trust fund meets all applicable NRC requirements, as discussed in Section 15.3.3.15;

- The self-guarantee is in an amount that is at least as great as the licensee's cost estimate or certification amount; and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a self-guarantee) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.12 External Sinking Funds

In addition to the evaluation criteria outlined in Section 15.3.1 above, an external sinking fund submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Prepayment mechanism (i.e., trust fund, escrow account, government fund, certificate of deposit, deposit, or deposit of government securities) and all supporting documentation
  - Surety method (i.e., surety bond, letter of credit, or line of credit) or insurance and all supporting documentation

- The external sinking fund is <u>not</u> being used to provide financial assurance for site control and maintenance following license termination under restricted conditions;

- The prepayment mechanism (i.e., trust, escrow, government fund, certificate of deposit, deposit of government securities) and the surety/insurance mechanism (i.e., surety bond, letter of credit, line of credit, insurance) that comprise the external sinking fund meet all applicable NRC requirements, as discussed earlier in this section; and

- The assurance provided by the prepayment mechanism, in combination with the assurance provided by the surety method or insurance, totals an amount that is at least as great as the licensee's decommissioning cost estimate or certification amount. <u>Exception</u>: Part 72 licensees that are electric utility licensees (as defined in 10 CFR Part 50) may use an external sinking fund without having to couple it with a surety method or insurance (i.e., they may use a gradually-funded prepayment mechanism only), in which case the amount of the fund may be below the cost estimate or certification amount prior to decommissioning.

15.3.3.13 Statements of Intent

In addition to the evaluation criteria outlined in Section 15.3.1 above, a statement of intent submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Statement of intent
  - Documentation verifying that the signatory is authorized to represent the licensee in providing the statement of intent

- The licensee is a Federal, State, or local government entity;

- The individuals signing the statement of intent on behalf of the licensee have the authority to request funds from the appropriate funding body;

- The statement of intent is in an amount that is at least as great as the licensee's cost estimate or certification amount -- unless the statement of intent is being used in combination with another financial assurance mechanism(s), in which case the amount of the statement of intent must at least equal the difference between the cost estimate or certification amount and the sum of the coverages being provided by the other mechanism(s); and

- No credit is taken for earnings on any financial assurance mechanism (e.g., a statement of intent) that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.14 Special Arrangements with a Government Entity That Assumes Custody and Ownership of the Site

In addition to the evaluation criteria outlined in Section 15.3.1 above, a special arrangement submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Documentation of the special arrangement

- The government entity has the authority to receive and hold funds for specified purposes (e.g., site control and maintenance);

- The arrangement provides financial assurance in an amount at least as great as the licensee's cost estimate; and

- No credit is taken for earnings on any special arrangement that does not set aside actual funds as prepayment for site control and maintenance activities.

15.3.3.15 Standby Trust Funds

In addition to the evaluation criteria outlined in Section 15.3.1 above, a standby trust fund submission must meet the following *additional* criteria:

- The following items have been included in the submission:

  - Standby trust agreement
  - Schedule A
  - Schedule B
  - Schedule C
  - Specimen certificate of events
  - Specimen certificate of resolution
  - Letter of acknowledgment

- The trustee is an appropriate State or Federal government agency or a financial institution that has the authority to act as trustee and whose trust operations are regulated and examined by a Federal or State agency. If evidence of the trustee's qualifications is not provided in the submission, the reviewer will evaluate the trustee's qualifications as follows:

- The word “National” in the title of a financial institution signals that the institution is *Federally regulated*, as do the words “National Association” or the initials “N.A.” following its title. To determine whether such a financial institution qualifies as an acceptable trustee, the reviewer will access the Federal Financial Institutions Examination Council’s (FFIEC) Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

  Alternatively, the reviewer may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution (1) is Federally regulated and (2) has Federally regulated trust operations. (The OCC’s home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

  - Northeastern District Office (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

  - Southeastern District Office (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

  - Central District Office (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

  - Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

  - Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

  - Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

- The word “State” in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable trustee, the reviewer will access the FFIEC’s Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

Alternatively, the reviewer may contact the applicable State banking authority and confirm that the institution (1) is State regulated, and (2) has State-regulated trust operations. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated. This is also often true in the case of domestic branches of foreign banks.

- The licensee has not assumed any real rate of return on funds in the standby trust that apply to decommissioning;

- The licensee has not assumed a real (i.e., inflation adjusted), after-tax rate of return greater than 2 percent per year on funds in the standby trust that apply to site control and maintenance;

- In the event that funds from the licensee's primary financial assurance mechanism(s) have been deposited into the standby trust fund, and under the appropriate assumptions regarding earnings on the trust, the current market value of the standby trust is sufficient to pay for all required activities;

- The maximum withdrawal of funds at one time for a particular activity (i.e., decommissioning or site control/maintenance) is limited to 10 percent of the remaining funds available for that activity unless approval from the appropriate party (i.e., NRC or the party responsible for site control and maintenance) is attached; and

- Schedule A to the standby trust agreement allows the trustee to access the full amount of coverage (using multiple withdrawals as necessary) to conduct all decommissioning and/or site control and maintenance activities. The amount shown in Schedule A must be at least as great as the licensee's cost estimate or certification amount.

Sample Evaluation Findings

The NRC staff has reviewed the financial assurance mechanism(s) for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 15 ("Financial Assurance for Decommissioning"). Based on this review, the NRC staff has determined that the financial assurance mechanism(s) submitted by the licensee is (are) adequate to ensure that sufficient funds will be available to carry out all required decommissioning activities prior to license termination and, if the license is being terminated under restricted conditions, to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site.

(Note: Appendix H to this SRP contains a sample post-review letter from the NRC to licensees for cases where no deficiencies are found in the submittal.)

NMSS DECOMMISSIONING PROGRAM

STANDARD REVIEW PLAN 16.0
RESTRICTED USE/ALTERNATE CRITERIA

The requirements of 10 CFR 20.1403 and 10 CFR 20.1404 are briefly summarized in Appendix I of this SRP. In addition, Appendix J contains guidance on seeking public advice on institutional controls which should be used to evaluate a licensee's or responsible parties' program for compliance with 10 CFR 20.1403(d)(1-2) and 10 CFR 20.1404 (a)(4).

RESPONSIBILITY FOR REVIEW

Primary:	NMSS	Division of Waste Management - Decommissioning Branch
		Division of Fuel Cycle Safety and Safeguards - Licensing Branch
	Region I:	Division of Nuclear Materials Safety - Decommissioning and Laboratory Branch
	Region II:	Division of Nuclear Materials Safety - Materials Licensing/Inspection Branch 1
	Region III:	Division of Nuclear Materials Safety - Decommissioning Branch
	Region IV:	Division of Nuclear Materials Safety - Nuclear Materials Licensing Branch, Fuel Cycle and Decommissioning Branch

Secondary: Environmental and Performance Assessment Branch, DWM/NMSS

Support: Office of the General Counsel

AREAS OF REVIEW

The staff will review the information supplied by the licensee or responsible party to determine if the description of the activities undertaken by the licensee or responsible party is adequate to allow the staff to conclude that the licensee or responsible party has complied with the applicable requirements of 10 CFR 20.1403, or 10 CFR 20.1404 for those licensees that intend to request termination of their radioactive materials licenses using either the restricted use or alternate criteria provisions of Subpart E.

If the licensee or responsible party is requesting license termination under restricted use this information should include: a demonstration that the licensee or responsible party qualifies for license termination under 10 CFR 20.1403(a); a description of the institutional controls the licensee or responsible party has instituted or plans to institute at the site; a description of the activities undertaken by the licensee or responsible party to obtain advice from the public on the proposed institutional controls and the results of these activities; a demonstration that the potential doses from residual radioactive material at the site will not exceed the limits in 10 CFR 20.1403 and are ALARA; and, a description of the financial assurance mechanism required under 10 CFR 20.1403 (c).

If the licensee or responsible party is requesting license termination using the alternate criteria provisions of 10 CFR 20.1404, the information should include: a description of the institutional controls the licensee or responsible party has instituted or plans to institute at the site; a demonstration that doses from residual radioactive material at the site will not exceed the limits in 10 CFR 20.1404(a)(1); a description of the restrictions on site use the licensee or responsible party has provided to comply with 10 CFR 20.1404(a)(2); a demonstration that the potential doses are ALARA; a description of the activities undertaken by licensee or responsible party to obtain advice from the public and the results of these activities[1]; and a description of the financial assurance mechanism required under 10 CFR 20.1403(c).

REVIEW PROCEDURES

Acceptance Review

The staff will ensure that the decommissioning plan contains the information summarized under "Areas of Review," above. Staff will review the licensee's or responsible party's descriptions of the 10 CFR 20.1403 or 10 CFR 20.1404 compliance activities without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed review. Staff will review the decommissioning plan table of contents and the individual descriptions under "Areas of Review," above, to ensure that the licensee or responsible party has included this information in the decommissioning plan and to determine if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review.

Safety Evaluation

The material to be reviewed is both informational and technical in nature. The staff will make a qualitative assessment as to whether the licensee's or responsible party's eligibility demonstration, description of institutional controls, description of financial assurance, and description of activities undertaken to obtain advice from the public on the proposed institutional controls and the results of these activities are adequate to allow the staff to conclude that the licensee or responsible party has complied with the requirements of 10 CFR 20.1403 or 10 CFR 20.1404. The staff will make a quantitative evaluation of the licensee's or responsible party's dose calculations and ALARA demonstrations.

[1] 10 CFR 20.1403 requires that licensees or responsible parties obtain advice from institutions and individuals that may be affected by the decommissioning on specific issues related to institutional controls and financial assurance. However, 10 CFR 20.1404 provides for a much broader discussion of the issues associated with the use of alternate criteria and, as such, licensees must obtain advice on essentially any issue associated with the use of alternate criteria.

16.1 RESTRICTED USE

16.1.1 ELIGIBILITY DEMONSTRATION

The purpose of the review of the licensee’s or responsible party’s demonstration that it is eligible to request release of the site under the provisions of 10 CFR 20.1403 is to verify that the licensee or responsible party has demonstrated that further reductions in residual radioactivity at the site to meet the unrestricted release criteria in 10 CFR 20.1402 would: (1) result in net public or environmental harm; or (2) are not being undertaken because the residual radioactivity levels are ALARA.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1403(a), 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee or responsible party should be sufficient to allow the staff to fully understand how the licensee has concluded that reducing radioactivity to the unrestricted use levels in 10 CFR 20.1402 would result in net public or environmental harm or are not being undertaken because the residual radioactivity levels are ALARA. The staff’s review should verify that the following information is included in the licensee’s or responsible party’s demonstration that it is eligible for requesting license termination under the provisions of 10 CFR 20.1403:

- A demonstration that the benefits of dose reduction are less than the cost of doses, injuries and fatalities (see Section 7 of this SRP); or
- A demonstration that the proposed residual radioactivity levels at the site are ALARA.

EVALUATION FINDINGS

Evaluation Criteria

If the licensee or responsible party has concluded that further reductions in residual radioactivity levels would result in net public or environmental harm, the staff should verify that the licensee has accurately calculated the benefits vs. costs of further remediation using the guidance in Section 7 of this SRP. In considering the net public and environmental harm a licensee's evaluation should consider the radiological and non-radiological impacts of decommissioning on person that may be impacted, as well as the potential impact on ecological systems from decommissioning activities (see Section B.3.2. of the "Statements of Consideration" for the License Termination Rule 62 FR 39069).

If the licensee or responsible party has concluded that further reductions in residual radioactivity levels are not required because they are ALARA, the staff should verify that the licensee or responsible party has considered all of the applicable benefits and costs of further reduction of residual radioactivity and accurately calculated the benefits and costs using the methodology described in Section 7 of this SRP.

Sample Evaluation Findings

The NRC staff has reviewed the licensee's justification for requesting license termination under restricted conditions in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 ("Restricted Use/Alternate Criteria").

Based on this review, the NRC staff has determined that the licensee [insert name and license number] has adequately demonstrated that [insert one] [the benefits of dose reduction are less than the cost of doses, injuries and fatalities] or [further reductions in radioactivity levels at the site are unnecessary because they are ALARA].

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B

16.1.2 INSTITUTIONAL CONTROLS

The purpose of the review of the description of the institutional controls the licensee or responsible party has provided for the site is to determine if the licensee or responsible party has made provisions for legally enforceable institutional controls that will limit the dose to the average member of the critical group to less than 0.25 mSv/yr (25 mrem/yr).

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1403(b)
- 10 CFR 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what institutional controls the licensee plans to use or has provided for the site and the manner in which these institutional controls will limit doses to the average member of the critical group to 0.25 mSv/yr (25 mrem/yr). The staff's review should verify that the following information is included in the description of institutional controls that the licensee plans to use or has provided for the site:

- A description of the legally enforceable institutional control(s) and an explanation of how the institutional control is a legally enforceable mechanism;
- A description of any detriments associated with the maintenance of the institutional control(s);
- A description of the restrictions on present and future landowners;
- A description of the entities enforcing, and their authority to enforce, the institutional control(s);
- A discussion of the durability[2] of the institutional control(s);
- A description of the activities that the entity with the authority to enforce the institutional controls may undertake to enforce the institutional control(s)
- The manner in which the entity with the authority to enforce the institutional control(s) will be replaced if that entity is no longer willing or able to enforce the institutional control(s) (this may not be needed for Federal or State entities);
- A description of the duration of the institutional control(s), the basis for the duration, the conditions that will end the institutional control(s) and the activities that will be undertaken to end the institutional control(s);
- A description of the plans for corrective actions that may be undertaken in the event the institutional control(s) fail; and

[2] The Commission has stated (see Section B3.3 of the "Statements of Consideration" for 10 CFR Part 20,Subpart E "Radiological Criteria for License Termination") that stringent institutional controls would be needed for sites involving large quantities of uranium and thorium contamination. Typically these would involve legally enforceable deed restrictions backed up by State and local government control or ownership, engineered barriers, and as appropriate, Federal ownership.

- A description of the records pertaining to the institutional controls, how and where will they will be maintained, and how the public will have access to the records.

EVALUATION FINDINGS

Evaluation Criteria

The staff should determine whether the information summarized under "Information to be Submitted," above satisfies the criteria summarized below. The application of the criteria below is dependent on the circumstances of the case. In each case the staff should consult with the Office of the General Counsel on the application of the criteria and the sufficiency of the licensee or responsible party's proposal.

A. For legally enforceable institutional controls on privately owned land

- Proprietary institutional controls on privately owned land should:

    1. Be enforceable against any owner of the affected property and any person that subsequently acquires the property or acquires any rights to use the property;

    2. Be enforceable by entities, other than the landowner, that have the legal authority to enforce the restriction;

    3. Be developed based on considerations of how durable the controls need to be;

    4. Include provisions to replace the entity with authority to enforce the restriction;

    5. Indicate actions the entity with authority to enforce the restrictions may take;

    6. Remain in place for the duration of the time they are needed;

    7. Have appropriate funds set aside if funds are necessary;

    8. Be appropriately recorded, including in the deed and in land records, as appropriate;

    9. Include a legal opinion by an attorney specializing in real estate law who is knowledgeable in the particular State and local land use laws that:

        a. The property law of the particular State and locality in which the land is located ensures that the particular instrument selected will accomplish its intended purpose;

        b The restrictions have been reviewed and their validity affirmed for the locality;

c. The owner of the affected property (i.e., the possessor of the land) can be compelled to abide by the terms of the use restriction; and
d. The restrictions are binding on future owners (possessors) of the land (i.e., they should “run with the land”).

10. Include a legal opinion that the entity with the right to restrict the land’s use and the responsibility to enforce the restriction has the legal authority to do so and is someone other than the owner or possessor of the land in question;

11. Include a demonstration that the entity (or entities) with authority to enforce the restrictions have the knowledge, capability, and willingness to do so, and are appropriate for the specific situation;

12. Include a demonstration that the institutional control is durable enough to provide an adequate level of protection of public health and safety and the environment for the amount of residual radioactivity remaining on the site;

13. Include a provision to replace the entity with authority to enforce the restriction if that entity is no longer willing or able to enforce the restriction;

14. Clearly state the actions that the parties with authority to enforce the restrictions may take to keep the restrictions functioning (e.g., monitoring of deed compliance, control and maintenance of physical barriers);

15. Include a demonstration that the restrictions will remain in place for the duration that they are needed, including periodic re-recording of the restrictions;

16. If restrictions will end, the conditions that would end the restriction must be clearly stated, and the procedures for canceling or amending the restriction should be readily available. There should be no provisions in the restriction or in the land use law of the local jurisdiction that would cause the restrictions to end while they are still needed to protect the public;

17. Identify corrective actions to be taken in case the restrictions need to be broken. For example, a no-excavation restriction may need to be broken if a water main under the site bursts and must be repaired;

18. Include a demonstration that the information about restrictions is recorded on the deed and on land records and will contain:

    a. A legal description of the property affected;
    b. The name or names of the current owner or owners of the property as reflected in public land records;
    c. Identification of the parties that can enforce the restriction (i.e., own the rights to restrict use of the land);

d. The reason for the restriction, the nature of the radiation hazard, including the estimated dose if institutional controls fail, and that this restriction is established as a condition of license termination by the NRC pursuant to 10 CFR 20.1403;

e. A statement describing the nature of the restriction, limitation, or control created by the restriction;
f. The duration of the restriction;
g. Permission to install and maintain physical controls, if any are used; and
h. The location of a copy of the final radiation status survey report for the facility at license termination.

B. For legally enforceable institutional controls on government owned land:

The NRC may accept government ownership of land as a method to enforce controls on land use and to meet the legally enforceable institutional control requirements in 10 CFR 20.1403(b) and (e). Government ownership will generally be acceptable when the dose to an average member of the critical group could exceed 100 mrem (1 mSv) per year (but be less than 500 mrem (5 mSv) per year) if the institutional controls were no longer in effect. In reviewing restrictions involving government ownership of land the NRC staff should ensure that the restriction will remain in place for the entire time they are needed and that the nature of the controls and restrictions on the land are clearly stated in a publicly available legal record. Depending on the government entity involved, consider as appropriate the items under #A, above.

C. For institutional controls based on sovereign or police powers:

Institutional controls that are based on sovereign or police powers generally consist of zoning or other restrictive requirements. The permissibility and effectiveness of governmental controls at a particular site will depend on the applicable State and local law.

- Institutional controls based on sovereign or police powers should:

  1. Include a legal opinion by an attorney specializing in real estate law who is knowledgeable in the particular State and local land use laws that:

     a. Zoning and other restrictive requirements have been reviewed and their validity affirmed; and
     b. They are binding on present and future owners of the land.

  2. Include a demonstration that the government agency imposing the zoning or restriction will assume responsibility for enforcing the restriction;

  3. Include a demonstration that the restrictions will remain in place for the entire time that they are needed or the conditions that can cause them to be changed;

4. Include a demonstration that the restrictions or zoning requirements are clear to current and future owners of the land, local and State governments, and others, as appropriate, through public documents, notification, placement in land records, etc. Such documentation should include an indication of the activities allowable and the residual radioactivity remaining on site.

Sample Evaluation Findings

The NRC staff has reviewed the description of the institutional controls in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 (Restricted Use/Alternate Criteria) and considered public comments made pursuant to 10 CFR 20.1405. The NRC staff has determined that the licensee [insert name] has adequately demonstrated that institutional controls are enforceable, durable and should ensure that doses to the public comply with the criteria in 10 CFR 20.1403. In addition, the licensee or responsible party has made adequate provisions to replace the entity charged with enforcing the institutional control in the event that the entity is no longer willing or able to enforce the institutional control and has made provisions to address corrective actions at the site.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. 1-2 pages summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees should be also encouraged to submit the information in electronic format.

16.1.3 SITE MAINTENANCE

The purpose of the review of the information about the license’s site maintenance program is to ensure that adequate arrangements have been made to ensure that the site will be maintained in accordance with the institutional controls described above and that the licensee has an adequate arrangement to ensure that an independent third party can assume and carry out responsibilities for any necessary control and maintenance of the site after the NRC has terminated the license. Criteria for evaluating the licensee’s or responsible parties’ mechanism to ensure that sufficient funds are available to allow an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site after the NRC has terminated the license are addressed in Section 15 of this SRP.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1403(c), 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to fully understand what arrangements for site maintenance have been provided by the licensee or responsible party. This should include descriptions of how the site maintenance arrangements will ensure that the site will be managed per the institutional controls described above and how an independent third party will assume and carry out responsibilities for any necessary control and maintenance of the site after the NRC has terminated the license. The staff's review should verify that the following information is included in the discussion of the site maintenance program in the facility decommissioning plan:

- A demonstration that an appropriately qualified entity has been provided to control and maintain the site;
- A description of the site maintenance and control program and the basis for concluding that the program is adequate to control and maintain the site;
- A description of the arrangement or contract with the entity charged with carrying out the actions necessary to maintain control at the site;
- A demonstration that the contract or arrangement will remain in effect for as long as feasible, and include provisions for renewing or replacing the contract;
- A description of the manner in which independent oversight of the entity charged with maintaining the site will be conducted and what entity will conduct the oversight;
- A demonstration that the entity providing the oversight has the authority to replace the entity charged with maintaining the site;
- A description of the authority granted to the third party to perform, or have performed, any necessary maintenance activities;
- Unless the entity is a government entity, a demonstration that the third party is not the entity holding the financial assurance mechanism;
- A demonstration that sufficient records evidencing to official actions and financial payments made by the third party are open to public inspection;
- A description of the periodic site inspections that will be performed by the third party, including the frequency of the inspections.

EVALUATION FINDINGS

Evaluation Criteria

The staff should determine whether that the information summarized under "Information to be Submitted," above satisfies the criteria summarized below. The application of the criteria below is dependent on the circumstances of the case. In each case the staff should consult with the Office of the General Counsel on the application of the criteria and the sufficiency of the licensee or responsible party's proposal.

- The entity to control and maintain the site may be the former licensee, the landowner, a governmental agency, an organization, a corporation or company, or occasionally a private individual. Control and maintenance of a site does not necessarily have to be carried out by an independent third party. The entity should be capable of carrying out its responsibilities and should be appropriate given the nature of the restrictions in place. The entity could be a contractor to the entity that holds the rights to restrict use of the property. Note that Government control and/or ownership is generally appropriate for sites involving large quantities of uranium and thorium contamination and for those site where the potential dose to the public could exceed 1 mSv/yr (100 mrem/yr) if institutional controls fail;

- The maintenance and control program includes detailed descriptions of: the repair/replacement and maintenance program for the site; if appropriate, an environmental monitoring program, including the duration of the monitoring, who will be informed of the results, action levels and what action will be taken if the action levels are exceeded; and the mechanism to detect and mitigate the loss of site controls; the mechanism to, if necessary, inform local emergency responders of the loss of controls;

- An arrangement or contract is in place to carry out any actions necessary to maintain the controls so that the annual dose to the average member of the critical group does not exceed 0.25 mSv (25 mrem). The arrangement or contract should be for as long a time as is feasible, and there should be provisions for renewing or replacing the contract to be consistent with the duration of the restrictions. The arrangement may include oversight of the entity by a government entity or the courts;

- A mechanism is in place to replace the entity controlling/maintaining the site if that becomes necessary. Replacement may be specified in the agreement with the conditions under which a government, the courts, or other entity can replace the entity;

- The entity is authorized to either perform the necessary work to maintain the controls or to contract for the performance of the work. The entity would need the authority to contract for the necessary work, review and approve the adequacy of the work performed, replace contractors if necessary, and authorize payment for the work;

- The entity performing the site control and maintenance should not hold the funds itself [i.e., the entity should not serve as the provider of financial assurance (e.g., escrow agent, trustee, issuer of letter of credit)]. However, if the entity is a government, the licensee may elect to allow the government to hold the funds;

- A demonstration that sufficient records evidencing the official actions of and financial payments made by the entity are open to public inspection;

- The entity has the responsibility to perform periodic checks of the site no less frequently than every 5 years (if required by 10 CFR 20.1403(e)(2)(iii)) to ensure that the institutional controls continue to function. The periodic checks should include an onsite inspection to verify that prohibited activities are not being conducted and that markers notices, and other physical controls remain in place. A review of the deed to ensure that the deed restrictions are still in place is not usually necessary, but the review should be performed if there is any cause to believe that the restrictions are not still properly part of the deed.

Sample Evaluation Findings

The NRC staff has reviewed the information regarding site maintenance and financial assurance in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 (Restricted Use/Alternate Criteria). Based on this review, the NRC staff has determined that the licensee [insert name] has adequately demonstrated that the site maintenance arrangements and financial assurance mechanism are adequate to ensure that the site will be maintained in accordance with the institutional controls described in the decommissioning plan and that sufficient funds are available to allow an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site after the NRC has terminated the license.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. One to two paragraphs summarizing the information in each of the bullets in “acceptance Criteria,”above. Licensees should be encouraged to submit the information in electronic format.

16.1.4 OBTAINING PUBLIC ADVICE

The purpose of the review of the license’s description of activities undertaken to obtain advice from the public on institutional controls is to determine if the advice of individuals and institutions in the community that may be affected by the decommissioning has been sought, evaluated, and as appropriate, incorporated into the licensee’s or responsible party’s decisions following an analysis of the advice.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1403(d), 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

None

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine whether the licensee or responsible party has adequately sought, managed, and, as appropriate, incorporated, advice from individuals and institutions that may be affected by the decommissioning alternative proposed by the licensee or responsible party.

10 CFR 20.1403(d)(1) requires that licensees proposing to decommission a site by restricting use of the site shall seek advice from affected parties on whether:

(1) the provisions for institutional controls will provide reasonable assurance that the total effective dose equivalent distinguishable from background radiation will not exceed 0.25 mSv/yr (25 mrem/yr);

(2) the provisions for institutional controls will be enforceable;

(3) the provisions for institutional controls will not impose an undue burden on the community or other affected parties; and,

(4) sufficient financial assurance has been provided to allow an independent third party to carry out any necessary control and maintenance activities at the site after license termination.

The staff's review should verify that the following information is included in the discussion of how advice was sought, obtained, evaluated, and as appropriate, incorporated for each[3] of the issues identified above:

- A description of how individuals and institutions that may be affected by the decommissioning were identified and informed of the opportunity to provide advice to the licensee or responsible party;

- A description of the manner in which the licensee obtained advice from these individuals or institutions;

- A description of how the licensee provided for participation by a broad cross-section of community interests in obtaining the advice;

- A description of how the licensee provided for a comprehensive, collective discussion of the issues by the participants represented;

[3]Note that each of the issues do not need to be addressed separately as long as the information required under the bullets is included for each issue

- A copy of the publicly available summary of the results of discussions, including individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants;

- A description of how this summary has been made available to the public; and

- A description of how the licensee evaluated the advice, and the rationale for incorporating, or not incorporating, the advice from affected members of the community into the decommissioning plan.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under "Information to be Submitted", above is included in the licensee's description of how advice was solicited, obtained, evaluated and as appropriate, incorporated into the licensee's or responsible party's decisions and decommissioning plan. The staff should verify that the manner in which advice was sought and obtained and the activities associated with obtaining this advice are consistent with the criteria in Appendix J of this SRP

Sample Evaluation Findings

The NRC staff has reviewed the information regarding how advice from individuals and institutions that may be affected by the decommissioning was obtained and summarized in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 ("Restricted Use/Alternate Criteria"). Based on this review, the NRC staff has determined that the licensee [insert name] has demonstrated that advice from individuals and institutions that may be affected by the decommissioning was sought, obtained, evaluated, and, as appropriate, incorporated into the licensee's plans for decommissioning its facility, in accordance with NRC requirements at 10 CFR 20.1403(d).

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Four to six paragraphs summarizing each of the items outlined in "Acceptance Criteria," above. Licensees are also encouraged to submit the information in electronic format.

16.1.5 DOSE MODELING AND ALARA DEMONSTRATION

The purpose of the review of the licensee's estimates of doses from the site after termination of the license to verify that the dose to the average member of the critical group will not exceed 25 mrem/yr with the institutional controls in place and that the doses are as low as reasonably achievable. The staff's review will also verify that, if institutional controls are no longer in place, there is reasonable assurance that the dose to the average member of the critical group from residual radioactive material at the site will not exceed 100 mrem/yr, or 500 mrem/yr provided that the licensee or responsible party:

1. Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/yr requirement are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

2. Makes provisions for durable institutional controls (see footnote 2); and,

3. Provides sufficient financial assurance to allow an independent third party to carry out rechecks at the site no less frequently than every 5 years and to assume and carry out responsibilities for any necessary control and maintenance of the controls at the site.

ACCEPTANCE CRITERIA

Regulatory Requirements

- 10 CFR 20.1403(e), 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

- Dose Modeling: Section 5 of this SRP
- ALARA: Section 7 of this SRP

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine whether the residual radioactive material at the site will not result in a TEDE that exceeds 25 mrem/yr with institutional controls in place and is ALARA, or that if institutional controls are no longer in place that there is reasonable assurance that the TEDE to the average member of the critical group will not exceed either 100 mrem/yr or 500 mrem/yr, with conditions. The information should also demonstrate that the financial assurance mechanism(s) are adequate for the site. Finally the information should be adequate to allow the staff to determine if the institutional controls and site maintenance activities are adequate.

The staff's review should verify that the following information is included in the dose modeling/ALARA demonstration subsection of the restricted use section of the decommissioning plan:

- A summary of the dose to the average member of the critical group when radionuclide levels are at the DCGL with institutional controls in place, as well as the estimated doses if they are no longer in place;

- A summary of the evaluation performed pursuant to Section 7 of this SRP demonstrating that these doses are ALARA;

- If the estimated dose to the average member of the critical group could exceed 100 mrem/yr (but would be less than 500 mrem/yr) when the radionuclide levels are at the DCGL, a demonstration that:

  1. Further reductions in residual radioactivity necessary to comply with the 100 mrem/yr requirement are not technically achievable, would be prohibitively expensive or would result in net public or environmental harm;

  2. Provisions for durable institutional controls are in place, and

  3. Sufficient financial assurance to allow an independent third party to carry out rechecks at the site no less frequently than every 5 years and to assume and carry out responsibilities for any necessary control and maintenance of the controls at the site has been provided.

EVALUATION FINDINGS

Evaluation Criteria

The staff should verify that the information summarized under “Information to be Submitted,” above, is included in the dose modeling/ALARA demonstration subsection of the restricted use section of the decommissioning plan. The staff should verify that the dose to the average member of the critical group when the radionuclide levels are at the DCGL does not exceed 25 mrem/yr with institutional controls in place and that the license estimated the dose in accordance with Section 5 of this SRP. The staff should verify that these doses are ALARA and that the licensee has made this evaluation in accordance with the criteria in Section 7 of this SRP. The staff should verify that the dose to the average member of the critical group will not exceed 100 mrem/yr when the radionuclide levels are at the DCGL , without institutional controls, and that the licensee or responsible party has estimated the dose in accordance with Section 5 of this SRP.

If the dose to the average member of the critical group could exceed 100 mrem/yr., without institutional controls, the staff should verify that the dose will not exceed 500 mrem/yr and that the licensee or responsible party has estimated the dose in accordance with Section 5 of this SRP. The staff should also verify that the licensee has determined that further reductions in residual radioactivity necessary to comply with the 100 mrem/yr requirement are not technically achievable, would be prohibitively expensive or would result in net public or environmental harm in accordance with SRP 7. The staff should verify that the institutional controls provided by the licensee or responsible party meet the criteria for a durable institutional controls (i.e., government ownership or responsibility as the third party). The staff should verify that the licensee or responsible party has provided sufficient financial assurance to allow an independent third party to carry out rechecks at the site at no less than every 5 years. The staff should verify that the amount of financial assurance is sufficient to assume and carry out responsibilities for any necessary control and maintenance of the controls at the site in accordance with Section 15 of this SRP.

Sample Evaluation Findings

The NRC staff has reviewed the information regarding compliance with 10 CFR 20.1403(e) summarized in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 (“Restricted Use/Alternate Criteria”). Based on this review, the NRC staff has determined that the licensee [insert name] has demonstrated that doses to the public from residual radioactive material after the license is terminated should not exceed 0.25 mSv/yr (25 mrem/yr), with restriction in place or [insert one: 1 mSv/yr (100 mrem/yr) if restrictions are removed, or 5 mSv/yr (500 mrem/yr), with conditions, if restrictions are removed].

If doses are estimated to be in excess of 1mSv/yr (100 mrem/yr), but less than 5 mSv/yr (500 mrem/yr) with institutional controls removed, insert the following:

“In addition the licensee [insert name] has demonstrated that further reductions in residual radioactivity necessary to comply with the 1 mSv/yr (100 mrem/yr requirement) [select as appropriate: are not technically achievable, are prohibitively expensive, or result in net public or environmental harm]. The licensee has also established durable institutional controls for the site. Finally, the licensee has provided sufficient financial assurance to allow an independent third party to carry out rechecks at the site at no less than every 5 years and the amount of financial assurance is sufficient to assume and carry out responsibilities for any necessary control and maintenance of the controls at the site.”

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. Three to five paragraphs summarizing each of the items outlined in “Acceptance Criteria,” above. Licensees should be encouraged to submit the information in electronic format.

16.2 ALTERNATE CRITERIA

For certain difficult sites with unique decommissioning problems, 10 CFR 20.1404 includes a provision by which the NRC may terminate a license using alternative dose criteria. The NRC expects the use of alternative criteria to be confined to rare situations. This provision was included in 10 CFR 20.1404 because the NRC believed that it is preferable to codify provisions for these difficult sites in the rule rather than require licensees to seek an exemption outside the rule. Under 10 CFR 20.1404, the NRC may consider terminating a license under alternative criteria that are greater than 0.25 mSv/yr (25 mrem/yr) (but less than 1 mSv (100 mrem/yr)), but the NRC limits the conditions under which a licensee could apply to the NRC for, or be granted use of, alternative criteria to unusual site-specific circumstances.

The purpose of the review of the licensee's discussion of why it is requesting license termination under the Alternate Criteria provisions of 10 CFR 20.1404 is to determine if the licensee or responsible party can demonstrate that the estimated doses to the public from all man-made sources other than medical will be less than 1 mSv/yr (100 mrem/yr) and are ALARA, that appropriate restrictions are in place at the site and that the licensee or responsible party has sought, obtained, evaluated and, as appropriate addressed, advice from individuals and institutions that may be affected by the decommissioning in accordance with the criteria in 10 CFR 20.1404.

ACCEPTANCE CRITERIA

Regulatory Requirements

10 CFR 20.1404, 30.36(g)(4)(ii), 40.42(g)(4)(ii), 70.38(g)(4)(ii) and 72.54(g)(2)

Regulatory Guidance

- Dose Modeling: Section 5 of this SRP
- ALARA: Section 7 of this SRP

Information to be Submitted

The information supplied by the licensee should be sufficient to allow the staff to determine whether the residual radioactive material at the site will result in a dose that exceeds 0.25 mSv/yr (25 mrem/yr), but will not exceed 1 mSv/yr (100 mrem/yr) (considering all man-made sources other than medical), when the radionuclide levels are at the DCGL and is ALARA. The information should also demonstrate that the financial assurance mechanism(s) are adequate for the site. Finally, the information should be adequate to allow the staff to determine if the institutional controls, site maintenance activities and the manner in which advice from individuals or institutions that could be affected by the decommissioning was sought, obtained, evaluated, and, as appropriate, addressed in accordance with NRC requirements. The staff should verify that the following information is included in the discussion of why the licensee or responsible party is requesting license termination under the provisions of 10 CFR 20.1404:

- A summary of the dose in TEDE(s) to the average member of the critical group when the radionuclide levels are at the DCGL (considering all man-made sources other than medical);
- A summary of the evaluation performed pursuant to Section 7 of this SRP demonstrating that these doses are ALARA;
- An analysis of all possible sources of exposure to radiation at the site and a discussion of why it is unlikely that the doses from all man-made sources, other than medical, will be more than 1 mSv/yr (100 mrem/yr);
- A description of the legally enforceable institutional control(s) and an explanation of how the institutional control is a legally enforceable mechanism;
- A description of any detriments associated with the maintenance of the institutional control(s);
- A description of the restrictions on present and future landowners;
- A description of the entities enforcing and their authority to enforce the institutional control(s);
- A discussion of the durability[4] of the institutional control(s);
- A description of the activities that the party with the authority to enforce the institutional controls will undertake to enforce the institutional control(s)
- The manner in which the entity with the authority to enforce the institutional control(s) will be replaced if that entity is no longer willing or able to enforce the institutional control(s)
- A description of the duration of the institutional control(s), the basis for the duration, the conditions that will end the institutional control(s) and the activities that will be undertaken to end the institutional control(s);
- A description of the corrective actions that will be undertaken in the event the institutional control(s) fail; and
- A description of the records pertaining to the institutional controls, how and where they will be maintained, and how the public will have access to the records.

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[4] See footnote 2.

- A description of how individuals and institutions that may be affected by the decommissioning were identified and informed of the opportunity to provide advice to the licensee or responsible party;

- A description of the manner in which the licensee obtained advice from affected individuals or institutions;

- A description of how the licensee provided for participation by a broad cross-section of community interests in obtaining the advice;

- A description of how the licensee provided for a comprehensive, collective discussion on the issues by the participants represented;

- A copy of the publicly available summary of the results of discussions, including individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants;

- A description of how this summary has been made available to the public; and,

- A description of how the licensee evaluated advice from individuals and institutions that could be affected by the decommissioning and the manner in which the advice was addressed.

EVALUATION FINDINGS

Evaluation Criteria

The staff should determine whether the information summarized under “Information to be Submitted”, above is included in the discussion of why the licensee or responsible party is requesting license termination under the provisions of 10 CFR 20.1404. The application of the criteria is dependent on the circumstances of the case. In each case the staff should consult with the Office of the General Counsel on the application of the criteria and the sufficiency of the licensee or responsible party’s proposal.

Review of the manner in which doses to the public should be estimated is addressed in Section 5 of this SRP and the staff should refer to Section 5 of this SRP to determine if the dose estimates developed by the licensee or responsible party are acceptable. The evaluation of these doses to determine if they are ALARA is addressed in Section 7 of this SRP and the staff should refer to Section 7 to review the licensee’s or responsible party’s demonstration that the doses are ALARA. The evaluation of the licensee’s or responsible party’s financial assurance mechanism(s) is addressed above and in Section 15 of this SRP and the staff should refer to these sections to review the financial assurance mechanisms. The evaluation of institutional controls, site maintenance activities, and obtaining advice from individual and institutions that could be affected by the decommissioning are addressed in Sections 16.1.3 and 16.1.4 of this SRP

Sample Evaluation Findings

The NRC staff has reviewed the information regarding the licensee's [insert name] request to decommission its facility pursuant to 10 CFR 20.1404, summarized in the Decommissioning Plan for the [insert name and license number of facility] located at [insert location of facility] according to the NMSS Decommissioning Standard Review Plan, Section 16 ("Restricted Use/Alternate Criteria") and considered public comments made pursuant to 10 CFR 20.1405. Based on this review, the NRC staff has determined that the licensee [insert name] has demonstrated that doses to the public from residual radioactive material after the license is terminated should be less than the NRC limits of 1 mSv/yr (100 mrem/yr) and are ALARA. In addition, the licensee has adequately demonstrated that it has provided appropriate restrictions according to the provisions of 10 CFR 20.1403 and has adequately sought, managed and addressed advice from individuals and institutions that may be affected by the decommissioning.

SUGGESTED FORMAT

1. Physical Specifications: See Appendix B
2. One to two pages summarizing each of the items outlined in Acceptance Criteria, above. Licensees should be encouraged to submit the information in electronic format.

APPENDIX A

ACCEPTANCE REVIEW CHECKLIST

ACCEPTANCE REVIEW CHECKLIST

LICENSEE NAME: ____
LICENSE NUMBER: __________________ DOCKET NUMBER: ______________
FACILITY:____
DECOMMISSIONING PLAN DATED/VERSION: ____________________________

Staff will review the decommissioning plan without assessing the technical accuracy or completeness of the information contained therein. The adequacy of this information will be assessed during the detailed technical review.

In most cases, licensees will not be required to submit all of the information in this checklist. Rather, the staff should use this checklist a basis for developing a site specific checklist for the individual facility. Staff should use the checklist first during the initial meetings with licensees to discuss the scope and content of the decommissioning plan for each site. The staff, in conjunction with the licensee, should determine what information should be submitted for the site, based on the uses of radioactive material at the site, the extent and types of radioactive material contamination, the manner in which the licensee intends to decommissioning the facility and other factors affecting the potential for increased risk to the public or workers from the decommissioning operations. This information should be documented by modifying the acceptance review checklist. Copies of the modified checklist should be provided to the licensee and maintained by the Project Manager. When the decommissioning plan is submitted the Project Manager should use the modified checklist to perform the acceptance review.

Staff will review the decommissioning plan table of contents and the individual decommissioning plan chapters or sections to ensure that the licensee or responsible party has included this information in the decommissioning plan. In addition, the staff may use the guidance regarding formatting and suggested length of individual as a guide in determining if the level of detail of the information appears to be adequate for the staff to perform a detailed technical review. Staff should recognize that failure to supply an item included in the checklist does not necessarily constitute grounds for rejecting the decommissioning plan. Rather, the staff should determine if the licensee can supply the information in a timely manner and if so communicate the additional information needs to the licensee in a deficiency letter. Only in those cases where a detailed technical review cannot begin without the required information should the DP be rejected. For example, if the licensee is requesting restricted release and has not obtained the appropriate input from community interests who could be affected by the decommissioning, the decommissioning plan should be rejected during the acceptance review. Questions regarding whether to reject a decommissioning plan based on the results of the acceptance review should be forwarded to the Decommissioning Branch, Division of Waste Management.

EXECUTIVE SUMMARY

___ the name and address of the licensee or owner of the site;
___ the location and address of the site;
___ a brief description of the site and immediate environs;
___ a summary of the licensed activities that occurred at the site
___ the nature and extent of contamination at the site;
___ the decommissioning objective proposed by the licensee (i.e., restricted or unrestricted use);
___ the DCGLs for the site, the corresponding doses from these DCGLs and the method that was use to determine the DCGLs;
___ a summary of the ALARA evaluations performed to support the decommissioning;
___ if the licensee or responsible party requests license termination under restricted conditions, the restrictions the licensee intends to use to limit doses as required in 10 CFR Part 20.1403 or 20.1404 and a summary of institutional controls, financial assurance.
___ if the licensee requests license termination under restricted conditions or using alternate criteria a summary of the public participation activities undertaken by the licensee to comply with 10 CFR Part 20.1403(d) or 20.1404(a)(4);
___ the proposed initiation and completion dates of decommissioning;
___ any post-remediation activities (such as groundwater monitoring) that the licensee proposes to undertake prior to requesting license termination; and
___ a statement that the licensee is requesting that its license be amended to incorporate the decommissioning plan

FACILITY OPERATING HISTORY

LICENSE NUMBER/STATUS/ AUTHORIZED ACTIVITIES

___ the radionuclides and maximum activities of radionuclides authorized and used under the current license;
___ the chemical forms of the radionuclides authorized and used under the current license;
___ a detailed description of how the radionuclides are currently being used at the site;
___ the location(s) of use and storage of the various radionuclides authorized under current licenses; and
___ a scale drawing or map of the building or site and environs showing current the locations of radionuclide use at the site;
___ a list of amendments to the license since the last license renewal.

LICENSE HISTORY

___ the radionuclides and maximum activities of radionuclides authorized and used under all previous licenses;
___ the chemical forms of the radionuclides authorized and used under all previous licenses;
___ a detailed description of how the radionuclides were used at the site;

___ the location(s) of use and storage of the various radionuclides authorized under all previous licenses
___ a scale drawing or map of the site, facilities and environs showing previous locations of radionuclide use at the site

PREVIOUS DECOMMISSIONING ACTIVITIES

___ a list or summary of areas at the site that were remediated in the past,
___ a summary of the types, forms, activities and concentrations of radionuclides that were present in previously remediated areas;
___ the activities that caused the areas to become contaminated;
___ the procedures used to remediate the areas and the disposition of radioactive material generated during the remediation;
___ a summary of the results of the final radiological evaluation of the previously remediated area
___ a scale drawing or map of the site, facilities and environs showing the locations of previous remedial activity

SPILLS

___ a summary of areas at the site where spills (or uncontrolled releases) of radioactive material occurred in the past;
___ the types, forms, activities and concentrations of radionuclides involved in the spill or uncontrolled release, and;
___ a scale drawing or map of the site, facilities and environs showing the locations of spills

PRIOR ON-SITE BURIALS

___ a summary of areas at the site where radioactive material has been buried in the past;
___ the types, forms, activities and concentrations of waste and radionuclides in the former burial, and;
___ a scale drawing or map of the site, facilities and environs showing the locations of former burials.

FACILITY DESCRIPTION

SITE LOCATION AND DESCRIPTION

___ the size of the site in acres or square meters;
___ the State and county in which the site is located;
___ the names and distances to nearby communities, towns and cities;
___ a description of the contours and features of the site;
___ the elevation of the site;
___ a description of property surrounding the site; including the location of all off-site wells used by nearby communities or individuals;
___ the location of the site relative to prominent features such as rivers and lakes.

___ a map that shows the detailed topography of the site using a contour interval
___ the location of the nearest residences and all significant facilities or activities near the site
___ a description of the facilities (buildings, parking lots, fixed equipment, etc.) at the site

POPULATION DISTRIBUTION

___ a summary of the current population in and around the site, by compass vectors
___ a summary of the projected population in and around the site by compass vectors
___ a list of minority populations by compass vectors
___ demographic data by census block group to identify minority or low-income populations

CURRENT/FUTURE LAND USE

___ a description of the current land uses in and around the site;
___ a summary of anticipated land uses.

METROLOGY AND CLIMATOLOGY

___ a description of the general climate of the region
___ seasonal and annual frequencies of severe weather phenomena
___ weather-related radionuclide transmission parameters
___ routine weather-related site deterioration parameters
___ extreme weather-related site deterioration parameters
___ a description of the local (site) meteorology
___ the National Ambient Air Quality Standards Category of the area in which the facility is located and, if the facility is not in a Category 1 zone, the closest and first downwind Category 1 Zone.

GEOLOGY AND SEISMOLOGY

___ a detailed description of the geologic characteristics of the site and the region around the site
___ a discussion of the tectonic history of the region, regional geomorphology, physiography, stratigraphy, and geochronology
___ a regional tectonic map showing the site location and its proximity to tectonic structures
___ a description of the structural geology of the region and its relationship to the site geologic structure
___ a description of any crustal tilting, subsidence, karst terrain, landsliding, and erosion.
___ a description of the surface and subsurface geologic characteristics of the site and its vicinity
___ a description of the geomorphology of the site
___ a description of the location, attitude, and geometry of all known or inferred faults in the site and vicinity
___ a discussion of the nature and rates of deformation
___ a description of any man-made geologic features such as mines or quarries.

___ a description of the seismicity of the site and region
___ a complete list of all historical earthquakes that have a magnitude of 3 or more or a modified Mercalli intensity of IV or more within 200 miles of the site.

SURFACE WATER HYDROLOGY

___ a description of site drainage and surrounding watershed fluvial features
___ water resource data including maps, hydrographs, and stream records from other agencies (e.g., U.S. Geological Survey and U.S. Army Corps of Engineers).
___ topographic maps of the site that show natural drainages and man-made features
___ a description of the surface water bodies at the site and surrounding areas
___ a description of existing and proposed water control structures and diversions (both upstream and downstream that may influence the site).
___ flow-duration data that indicate minimum, maximum, and average historical observations for surface water bodies in the site areas
___ aerial photography and maps of the site and adjacent drainage areas identifying features such as drainage areas, surface gradients, and areas of flooding.
___ an inventory of all existing and planned surface water users, whose intakes could be adversely affected by migration of radionuclides from the site
___ topographic and/or aerial photographs that delineate the 100-year floodplain at the site
___ a description of any man-made changes to the surface water hydrologic system that may influence the potential for flooding at the site

GROUNDWATER HYDROLOGY

___ a description of the saturated zone
___ descriptions of monitoring wells
___ physical parameters
___ a description of groundwater flow directions and velocities
___ a description of the unsaturated zone
___ information on all monitor stations including location and depth
___ a description of physical parameters
___ a description of the numerical analyses techniques used to characterize the unsaturated and saturated zones
___ the distribution coefficients of the radionuclides of interest at the site.

NATURAL RESOURCES

___ a description of the natural resources occurring at or near the site
___ a description of potable, agricultural, or industrial ground or surface waters
___ a description of economic, marginally economic, or subeconomic known or identified natural resources as defined in U.S. Geological Survey Circular 831.
___ mineral, fuel, and hydrocarbon resources near and surrounding the site which, if exploited, would effect the licensee' or responsible party's dose estimates

ECOLOGY/ENDANGERED SPECIES

___ a list of commercially or recreationally important invertebrate species known to occur within 5 km of the site
___ a list of all commercially important floral species known to occur within 5 km of the site
___ a list of commercially or recreationally important vertebrate animals known to occur within 5 km of the site.
___ estimates of the relative abundance of both commercially and recreationally important game and nongame vertebrates
___ a list of all endangered species at or within 5 km of the site

RADIOLOGICAL STATUS OF FACILITY

CONTAMINATED STRUCTURES

___ a list or description of all structures at the facility where licensed activities occurred that contain residual radioactive material in excess of site background levels;
___ a summary of the structures and locations at the facility that the licensee or responsible party has concluded have not been impacted by licensed operations and the rationale for the conclusion;
___ a list or description of each room or work area within each of these structures;
___ a summary of the background levels used during scoping or characterization surveys;
___ a summary of the locations of contamination in each room or work area
___ a summary of the radionuclides present at each location, the maximum and average radionulide activities in dpm/100cm^2, and, if multiple radionuclides are present, the radionuclide ratios;
___ the mode of contamination for each surface (i.e., whether the radioactive material is present only on the surface of the material or if it has penetrated the material);
___ the maximum and average radiation levels in mrem/hr in each room or work area; and
___ a scale drawing or map of the rooms or work areas showing the locations of radionuclide material contamination.

CONTAMINATED SYSTEMS AND EQUIPMENT

___ a list or description and the location of all systems or equipment at the facility that contain residual radioactive material in excess of site background levels;
___ a summary of the radionuclides present in each systems or on the equipment at each location, the maximum and average radionulide activities in dpm/100cm^2, and, if multiple radionuclides are present, the radionuclide ratios;
___ the maximum and average radiation levels in mrem/hr at the surface of each piece of equipment;
___ a summary of the background levels used during scoping or characterization surveys; and,
___ a scale drawing or map of the rooms or work areas showing the locations of the contaminated systems or equipment;

SURFACE SOIL CONTAMINATION

___ a list or description of all locations at the facility where surface soil contains residual radioactive material in excess of site background levels;
___ a summary of the background levels used during scoping or characterization surveys
___ a summary of the radionuclides present at each location, the maximum and average radionuclide activities in pCi/gm, and, if multiple radionuclides are present, the radionuclide ratios;
___ the maximum and average radiation levels in mrem/hr at each location; and
___ a scale drawing or map of the site showing the locations of radionuclide material contamination in surface soil;

SUBSURFACE SOIL CONTAMINATION

___ a list or description of all locations at the facility where subsurface soil contains residual radioactive material in excess of site background levels;
___ a summary of the background levels used during scoping or characterization surveys
___ a summary of the radionuclides present at each location, the maximum and average radionulide activities in pCi/gm, and, if multiple radionuclides are present, the radionuclide ratios;
___ the depth of the subsurface soil contamination at each location; and
___ a scale drawing or map of the site showing the locations of subsurface soil contamination.

SURFACE WATER

___ a list or description of all surface water bodies at the facility that contain residual radioactive material in excess of site background levels;
___ a summary of the background levels used during scoping or characterization surveys
___ a summary of the radionuclides present in each surface water body and the maximum and average radionuclide activities in pCi/l.

GROUNDWATER

___ a summary of the aquifer(s) at the facility that contain residual radioactive material in excess of site background levels;
___ a summary of the background levels used during scoping or characterization surveys
___ a summary of the radionuclides present in each aquifer and the maximum and average radionulide activities in pCi/l

DOSE MODELING

UNRESTRICTED RELEASE USING SCREENING CRITERIA

Unrestricted release using screening criteria for building surface residual radioactivity

___ the general conceptual model (for both the source term and the building environment) of the site; and,

___ a summary of the screening method (i.e., running DandD or using the look-up tables) used in the decommissioning plan.

Unrestricted release using screening criteria for surface soil residual radioactivity

___ justification on the appropriateness of using the screening approach (for both the source term and the environment) at the site; and,

___ a summary of the screening method (i.e., running DandD or using the look-up tables) used in the decommissioning plan.

UNRESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION

___ source term information including nuclides of interest, configuration of the source, areal variability of the source, etc.

___ description of the exposure scenario including a description of the critical group.

___ description of the conceptual model of the site including the source term, physical features important to modeling the transport pathways, and the critical group.

___ identification/description of the mathematical model used (e.g., hand calculations, DandD Screen v1.0, RESRAD v5.81, etc.).

___ description of the parameters used in the analysis.

___ discussion about the effect of uncertainty on the results.

___ input and output files or printouts, if a computer program was used.

RESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION

___ source term information including nuclides of interest, configuration of the source, areal variability of the source, and chemical forms;

___ a description of the exposure scenarios including a description of the critical group for each scenario;

___ a description of the conceptual model(s) of the site that includes the source term, physical features important to modeling the transport pathways, and the critical group for each scenario;

___ identification/description of the mathematical model(s) used (e.g., hand calculations, RESRAD v5.81, etc.);

___ a summary of parameters used in the analysis;

___ a discussion about the effect of uncertainty on the results; and

___ input and output files or printouts, if a computer program was used.

RELEASE INVOLVING ALTERNATE CRITERIA

___ source term information including nuclides of interest, configuration of the source, areal variability of the source, and chemical forms;

___ a description of the exposure scenarios including a description of the critical group for each scenario;

___ a description of the conceptual model(s) of the site that includes the source term, physical features important to modeling the transport pathways, and the critical group for each scenario;
___ identification/description of the mathematical model(s) used (e.g., hand calculations, RESRAD v5.81, etc.);
___ a summary of parameters used in the analysis;
___ a discussion about the effect of uncertainty on the results; and
___ input and output files or printouts, if a computer program was used.

ALTERNATIVES CONSIDERED AND RATIONALE FOR CHOSEN ALTERNATIVE

ALTERNATIVES CONSIDERED

___ a description of the facility if the alternative is employed;
___ a summary of the health effects to adjacent communities if the alternative is employed;
___ a summary of the impacts on community resources such as land use and property values;
___ a summary of the impacts on the geology, hydrology, air quality and ecology in and around the site;
___ a description of impacts to minority or low-income populations within a 0.6 mile radius of the center of the facility (urban location) or within a 4 mile radius of the center of the facility (rural location);
___ if appropriate, an assessment of the potential for criticality;
___ a summary of the irreversible and irretrievable commitment of resources.
___ an analysis of the proposed alternative and other alternatives as required by 10 CFR 51.45(c);
___ a list of the permits, licenses, approvals, and other entitlements and the discussion of the status of compliance with these requirements required in 10 CFR 51.45(d)

RATIONALE FOR CHOSEN ALTERNATIVE

___ a description of why the licensee selected the preferred alternative described in the decommissioning plan
___ if the licensee has not selected the environmentally preferable alternative, an explanation of why this alternative was not selected.

ALARA ANALYSIS

___ a description of how the licensee or responsible party will achieve a decommissioning goal below the dose limit;
___ a quantitative cost benefit analysis;
___ a description of how costs were estimated; and,
___ a demonstration that the doses to the average member of the critical group are ALARA

PLANNED DECOMMISSIONING ACTIVITIES

CONTAMINATED STRUCTURES

___ a summary of the remediation tasks planned for each room or area in the contaminated structure in the order in which they will occur;

___ a description of the remediation techniques that will be employed in each room or area of the contaminated structure;

___ a summary of the radiation protection methods and control procedures that will be employed in each room or area;

___ a summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;

___ a commitment to conduct decommissioning activities in accordance with written, approved procedures;

___ a summary of any unique safety or remediation issues associated with remediating the room or area; and,

___ for Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

CONTAMINATED SYSTEMS AND EQUIPMENT

___ a summary of the remediation tasks planned for each system in the order in which they will occur including which activities will be conducted by licensee staff and which will be performed by a contractor;

___ a description of the techniques that will be employed to remediate each system in the facility or site;

___ a description of the radiation protection methods and control procedures that will be employed while remediating each system;

___ a summary of the equipment will be removed or decontaminated and how the decontamination will be accomplished;

___ a summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;

___ a commitment to conduct decommissioning activities in accordance with written, approved procedures;

___ a summary of any unique safety or remediation issues associated with remediating any system or piece of equipment; and,

___ for Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

SOIL

___ a summary of the removal/remediation tasks planned for surface and subsurface soil at the site in the order in which they will occur including which activities will be conducted by licensee staff and which will be performed by a contractor;

___ a description the techniques that will be employed to remove or remediate surface and subsurface soil at the site;

___ a description of the radiation protection methods and control procedures that will be employed during soil removal/remediation;
___ a summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan;
___ a commitment to conduct decommissioning activities in accordance with written, approved procedures;
___ a summary of any unique safety or removal/remediation issues associated with remediating the soil; and,
___ for Part 70 licensees, a summary of how the licensee will ensure that the risks addressed in the facility's Integrated Safety Analysis will be addressed during decommissioning.

SURFACE AND GROUNDWATER

___ a summary of the remediation tasks planned for ground and surface water in the order in which they will occur, including which activities will be conducted by licensee staff and which will be performed by a contractor;
___ a description the remediation techniques that will be employed to remediate the ground or surface water;
___ a description of the radiation protection methods and control procedures that will be employed during ground or surface water remediation
___ a summary of the procedures already authorized under the existing license and those for which approval is being requested in the decommissioning plan
___ a commitment to conduct decommissioning activities in accordance with written, approved procedures; and,
___ a summary of any unique safety or remediation issues associated with remediating the ground or surface water.

SCHEDULES

___ a Gantt or PERT chart detailing the proposed remediation tasks in the order in which they will occur
___ a statement acknowledging that the dates in the schedule are contingent on NRC approval of the decommissioning plan;
___ a statement acknowledging that circumstances can change during decommissioning, and, if the licensee determines that the decommissioning cannot be completed as outlined in the schedule, the licensee or responsible party will provide an updated schedule to NRC; and,
___ If the decommissioning is not expected to be completed within the timeframes outlined in NRC regulations, a request for alternative schedule for completing the decommissioning

PROJECT MANAGEMENT AND ORGANIZATION

DECOMMISSIONING MANAGEMENT ORGANIZATION

___ a description of the decommissioning organization
___ a description of the responsibilities of each of these decommissioning project units;
___ description of the reporting hierarchy within the decommissioning project management organization
___ a description of the responsibility and authority of each unit to ensure that decommissioning activities are conducted in a safe manner and in accordance with approved written procedures

DECOMMISSIONING TASK MANAGEMENT

___ a description of the manner in which the decommissioning tasks are managed
___ a description of how individual decommissioning tasks are evaluated and how the RWPs are developed for each task;
___ a description of how the RWPs are reviewed and approved by the decommissioning project management organization;
___ a description of how RWPs are managed throughout the decommissioning project
___ a description of how individuals performing the decommissioning tasks are informed of the procedures in the RWP

DECOMMISSIONING MANAGEMENT POSITIONS AND QUALIFICATIONS

___ a description of the duties and responsibilities of each management position in the decommissioning organization and the reporting responsibility of the position;
___ a description of the duties and responsibilities of each chemical, radiological, physical and occupational safety-related position in the decommissioning organization and the reporting responsibility of the position;
___ a description of the duties and responsibilities of each engineering, quality assurance, and waste management position in the decommissioning organization and the reporting responsibility of the position
___ the minimum qualifications for each of the positions describe above, and the qualifications of the individuals currently occupying the positions
___ a description of all decommissioning and safety committees

Radiation Safety Officer

___ a description of the health physics and radiation safety education and experience required for individuals acting as the licensee's or responsible party's RSO
___ a description of the responsibilities and duties of the RSO; and
___ a description of the specific authority of the RSO to implement and manage the licensee's or responsible party' radiation protection program

TRAINING

___ a description of the radiation safety training that the licensee will provide to each employee

___ a description of any daily worker “jobside” or “tailgate” training that will be provided at the beginning of each workday or job task to familiarize workers with job-specific procedures or safety requirements
___ a description of the documentation that will be maintained to demonstrate that training commitments are being met.

CONTRACTOR SUPPORT

___ a summary of decommissioning tasks that will be performed by contractors
___ a description of the management interfaces that will be in place between the licensee or responsible party’s management and on-site supervisors and contractor management and on-site supervisors;
___ a description of the oversight responsibilities and authority that the licensee or responsible party will exercise over contractor personnel;
___ a description of the training that will be provided to contractor personnel by the licensee or responsible party and the training that will be provided by the contractor
___ a commitment that the contractor will comply with all radiation safety and license requirements at the facility.

HEALTH AND SAFETY PROGRAM DURING DECOMMISSIONING

RADIATION SAFETY CONTROLS AND MONITORING FOR WORKERS

Air Sampling Program

___ a description which demonstrates that the air sampling program is representative of the workers breathing zones
___ a description of the criteria which demonstrates that air samplers with appropriate sensitivities will be used; and that samples will be collected at appropriate frequencies
___ a description of the conditions under which air monitors will be used
___ a description of the criteria used to determine the frequency of calibration of the flow meters on the air samplers
___ a description of the action levels for air sampling results
___ a description of how minimum detectable activities [MDA] for each specific radionuclide that may be collected in air samples are determined

Respiratory Protection Program

___ a description of the process controls, engineering controls or procedures to control concentrations of radioactive materials in air;
___ a description of the evaluation which will be performed when it is not practical to apply engineering controls or procedures
___ a description of the considerations used which demonstrates respiratory protection equipment is appropriate for a specific task based on the guidance on assigned protection factors;

___ a description of the medical screening and fit testing required before workers will use any respirator that is assigned a protection factor;
___ a description of the written procedures maintained to address all the elements of the respiratory protection program;
___ a description of the use, maintenance, and storage of respiratory protection devices
___ a description of the respiratory equipment users training program;
___ a description of the considerations made when selecting respiratory protection equipment

Internal Exposure Determination

___ a description of the monitoring to be performed to determine worker exposure
___ a description of how worker intakes are determined using measurements of quantities of radionuclides excreted from, or retained in the human body
___ a description of how worker intakes are determined by measurements of the concentrations of airborne radioactive materials in the workplace.
___ a description of how worker intakes, for an adult, a minor, and a declared pregnant woman are determined using any combination of the measurements above as may be necessary
___ a description of how worker intakes are converted into committed effective dose equivalent

External Exposure Determination

___ a description of the individual-monitoring devices which will be provided to workers
___ a description of the type, range, sensitivity, and accuracy of each individual-monitoring device;
___ a description of the use of extremity and whole body monitors when the external radiation field is non-uniform
___ a description of when audible-alarm dosimeters and pocket dosimeters will be provided
___ a description of how external dose from airborne radioactive material is determined
___ a description of the procedure to insure that surveys necessary to supplement personnel monitoring are performed
___ a description of the action levels for worker's external exposure, and the technical bases and actions to be taken when they are exceeded.

Summation of Internal and External Exposures

___ a description of how the internal and external monitoring results are used to calculate TODE and TEDE doses to occupational workers;
___ a description of how internal doses to the embryo/fetus, which is based on the intake of an occupationally-exposed, declared, pregnant woman will be determined;
___ a description of the monitoring of the intake of a declared, pregnant woman if determined to be necessary;

___ a description of the program for the preparation, retention and reporting of records for occupational radiation exposures;

Contamination Control Program

___ a description of the written procedures to control access to, and stay time in, contaminated areas by workers if they are needed

___ a description of surveys to supplement personnel monitoring for workers during routine operations, maintenance, clean-up activities, and special operations;

___ a description of the surveys which will be performed to determine the baseline of background radiation levels and radioactivity from natural sources for areas where decommissioning activities will take place;

___ a description in matrix or tabular form which describes contamination action limits (that is, actions taken to either decontaminate a person, place or area, or restrict access, or modify the type or frequency of radiological monitoring)

___ a description (included in the matrix or table mentioned above) of proposed radiological contamination guidelines for specifying and modifying the frequency for each type of survey used to assess the reduction of total contamination

___ a description of the procedures used to test sealed sources, and to insure that sealed sources are leaked tested at appropriate intervals

Instrumentation Program

___ a description of the instruments to be used to support the health and safety program

___ a description of instrumentation storage, calibration and maintenance facilities for instruments used in field surveys

___ a description of the method used to estimate the MDC or MDA (at the 95% confidence level) for each type of radiation to be detected;

___ a description of the instrument calibration and quality assurance procedures;

___ a description of the methods used to estimate uncertainty bounds for each type of instrumental measurement;

___ a description of air sampling calibration procedures or a statement that the instruments will be calibrated by an accredited laboratory.

Nuclear Criticality Safety

___ a description of how the NCS functions, including management responsibilities and technical qualifications of safety personnel, shall be maintained when needed throughout the decommissioning process;

___ a description of how an awareness of procedures and other items relied on for safety shall be maintained throughout decommissioning among all personnel with access to systems that may contain fissionable material in sufficient amounts for criticality;

___ a summary of the review of NCSA’s or the ISA indicating either that the process needs no new safety procedures or requirements, or that new requirements or analysis have been performed; and

___ a summary of any generic NCS requirements to be applied to general decommissioning, decontamination, or dismantlement operations, including those dealing with systems that may unexpectedly contain fissionable material.

Health Physics Audits, Inspections and Record-Keeping Program.

___ a general description of the annual program review conducted by executive management
___ a description of the records to be maintained of the annual program review and executive audits
___ a description of the types and frequencies of surveys and audits to be performed by the RSO and RSO staff
___ a description of the process used in evaluating and dealing with violations of NRC requirements or license commitments identified during audits
___ a description of the records maintained of RSO audits

ENVIRONMENTAL MONITORING AND CONTROL PROGRAM

ENVIRONMENTAL ALARA EVALUATION PROGRAM

___ a description of ALARA goals for effluent control;
___ a description of the procedures, engineering controls, and process controls to maintain doses ALARA
___ a description of the ALARA reviews and reports to management.

EFFLUENT MONITORING PROGRAM

___ a demonstration that background and baseline concentrations of radionuclides in environmental media have been established through appropriate sampling and analysis;
___ a description of the known or expected concentrations of radionuclides in effluents;
___ a description of the physical and chemical characteristics of radionuclides in effluents;
___ a summary or diagram of all effluent discharge locations;
___ a demonstration that samples will be representative of actual releases;
___ a summary of the sample collection and analysis procedures
___ a summary of the sample collection frequencies;
___ a description of the environmental monitoring recording and reporting procedures; and
___ a description of the quality assurance program to be established and implemented for the effluent monitoring program

EFFLUENT CONTROL PROGRAM

___ a description of the controls that will be used to minimize releases of radioactive material to the environment;
___ a summary of the action levels and description of the actions to be taken should a limit be exceeded;
___ a description of the leak detection systems for ponds, lagoons, and tanks;

___ a description of the procedures to ensure that releases to sewer systems are controlled and maintained to meet the requirements of 10 CFR 20.2003, and
___ a summary of the estimates of doses to the public from effluents and a description of the method used to estimate public dose.

RADIOACTIVE WASTE MANAGEMENT PROGRAM

SOLID RADWASTE

___ a summary of the types of solid radwaste that are expected to be generated during decommissioning operations
___ a summary of the estimated volume, in cubic feet, of each solid radwaste type summarized under bullet 1 above;
___ a summary of the radionuclides (including the estimated activity of each radionuclide) in each estimated solid radwaste type summarized under bullet 1 above;
___ a summary of the volumes of Class A, B, C and Greater-than-Class-C solid radwaste that will be generated by decommissioning operations;
___ a description of how and where each of the solid radwaste summarized under bullet 1 above, will be stored on-site prior to shipment for disposal;
___ a description of how the each of the solid radwastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal;
___ if appropriate, how the licensee or responsible party intends to manage volumetrically contaminated material;
___ a description of how the licensee or responsible party will prevent contaminated soil, or other loose solid radwaste, from being re-disbursed after exhumation and collection; and
___ the name and location of the disposal facility that the licensee intends to use for each solid radwaste type summarized under bullet 1 above

LIQUID RADWASTE

___ a summary of the types of liquid radwaste that are expected to be generated during decommissioning operations
___ a summary of the estimated volume, in liters, of each liquid radwaste type summarized under bullet 1 above;
___ a summary of the radionuclides (including the estimated activity of each radionuclide) in each liquid radwaste type summarized under bullet 1 above;
___ a summary of the estimated volumes of Class A, B, C and Greater-than-Class-C liquid radwaste that will be generated by decommissioning operations;
___ a description of how and where each of the liquid radwastes summarized under bullet 1 above, will be stored on-site prior to shipment for disposal;
___ a description of how the each of the liquid radwastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal;
___ the name and location of the disposal facility that the licensee intends to use for each liquid radwaste type summarized under bullet 1 above

MIXED WASTE

- ___ a summary of the types of solid and liquid mixed waste that are expected to be generated during decommissioning operations;
- ___ a summary of the estimated volumes, in cubic feet of each solid mixed waste type summarized under bullet 1 above and in liters for each liquid mixed waste;
- ___ a summary of the radionuclides (including the estimated activity of each radionuclide) in each type of mixed waste type summarized under bullet 1 above;
- ___ a summary of the estimated volumes of Class A, B, C and Greater-than-Class-C mixed waste that will be generated by decommissioning operations;
- ___ a description of how and where each of the mixed wastes summarized under bullet 1 above, will be stored on-site prior to shipment for disposal;
- ___ a description of how the each of the mixed wastes summarized under bullet 1 above, will be treated and packaged to meet disposal site acceptance criteria prior to shipment for disposal;
- ___ the name and location of the disposal facility that the licensee intends to use for each mixed waste type summarized under bullet 1 above;
- ___ a discussion of the requirements of all other regulatory agencies having jurisdiction over the mixed waste; and,
- ___ a demonstration the that the licensee possess the appropriate EPA or State permits to generate, store and/or treat the mixed wastes;

<u>QUALITY ASSURANCE PROGRAM</u>

ORGANIZATION

- ___ a description of the QA program management organization,
- ___ a description of the duties responsibilities of each unit within the organization and how delegation of responsibilities is managed within the decommissioning program
- ___ a description of how work performance is evaluated;
- ___ a description of the authority of each unit within the QA program
- ___ an organization chart of the QA program organization

QUALITY ASSURANCE PROGRAM

- ___ a commitment that activities affecting the quality of site decommissioning will be subject to the applicable controls of the QA program and activities covered by the QA program are identified on program defining documents;
- ___ a brief summary of the company's corporate QA policies;
- ___ a description of provisions to ensure that technical and quality assurance procedures required to implement the QA program are consistent with regulatory, licensing, and QA program requirements and are properly documented and controlled;
- ___ a description of the management reviews, including the documentation of concurrence in these quality-affecting procedures;
- ___ a description of the quality-affecting procedural controls of the principal contractors

___ a description of how NRC will be notified of changes (a) for review and acceptance in the accepted description of the QA program as presented or referenced in the DP before implementation and (b) in organizational elements within 30 days after the announcement of the changes
___ a description is provided of how management regularly assesses the scope, status, adequacy, and compliance of the QA program;
___ a description of the instruction provided to personnel responsible for performing activities affecting quality
___ a description of the training and qualifications of personnel verifying activities
___ for formal training and qualification programs, documentation includes the objectives and content of the program, attendees, and date of attendance;
___ a description of the self-assessment program to confirm that activities affecting quality comply with the QA program;
___ a commitment that persons performing self-assessment activities are not to have direct responsibilities in the area they are assessing;
___ a description of the organizational responsibilities for ensuring that activities affecting quality are (a) prescribed by documented instructions, procedures, and drawings; and, (b) accomplished through implementation of these documents; and,
___ a description of the procedures to ensure that instructions, procedures, and drawings include quantitative acceptance criteria and qualitative acceptance criteria for determining that important activities have been satisfactorily performed.

DOCUMENT CONTROL

___ a summary of the types of QA documents that are included in the program
___ a description of how the licensee or responsible party develops, issues, revises and retires QA documents

CONTROL OF MEASURING AND TEST EQUIPMENT

___ a summary of the test and measurement equipment used in the program
___ description of how and at what frequency the equipment will be calibrated;
___ a description of the daily calibration checks that will be performed on each piece of test or measurement equipment;
___ a description of the documentation that will be maintained to demonstrate that only properly calibrated and maintained equipment was used during the decommissioning

CORRECTIVE ACTION

___ a description of the corrective action procedures for the facility, including a description of how the corrective action is determined to be adequate;
___ a description of the documentation maintained for each corrective action and any followup activities by the QA organization after the corrective action is implemented;

QUALITY ASSURANCE RECORDS

___ a description of the manner in which the QA records will be managed
___ a description of the responsibilities of the QA organization
___ a description of the QA records storage facility.

AUDITS AND SURVEILLANCES

___ a description of the audit program
___ a description of the records and documentation generated during the audits and the manner in which the documents are managed
___ a description of all followup activities associated with audits or surveillances
___ a description of the trending/tracking that will be performed on the results of audits and surveillances

FACILITY RADIATION SURVEYS

RELEASE CRITERIA

___ a summary table or list of the $DCGL_W$ for each radionuclide and impacted media of concern;
___ if Class 1 survey units are present, a summary table or list of area factors that will be used for determining a $DCGL_{EMC}$ for each radionuclide and media of concern;
___ if Class 1 survey units are present, the $DCGL_{EMCs}$ for each radionuclide and medium of concern;
___ if multiple radionuclides are present, the appropriate $DCGL_W$ for the survey method to be used.

CHARACTERIZATION SURVEYS

___ a description and justification of the survey measurements for impacted media
___ description of the field instruments and methods that were used for measuring concentrations and the sensitivities of those instruments and methods;
___ a description of the laboratory instruments and methods that were used for measuring concentrations and the sensitivities of those instruments and methods;
___ the survey results including tables or charts of the concentrations of residual radioactivity measured;
___ maps or drawings of the site, area, or building showing areas classified as non-impacted or impacted
___ justification for considering areas to be non-impacted;
___ a discussion of why the licensee considers the characterization survey to be adequate to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected;
___ for areas and surfaces that are inaccessible or not readily accessible, a discussion of how they were surveyed or why they did not need to be surveyed;

___ for sites, areas, or buildings with multiple radionuclides, a discussion justifying the ratios of radionuclides that will be assumed in the final status survey or an indication that no fixed ratio exists and each radionuclide will be measured separately.

REMEDIAL ACTION SUPPORT SURVEYS

___ a description of field screening methods and instrumentation;
___ a demonstration that field screening should be capable of detecting residual radioactivity at the DCGL;

FINAL STATUS SURVEY DESIGN

___ a brief overview describing the final status survey design.
___ a description and map or drawing of impacted areas of the site, area, or building classified by residual radioactivity levels (Class 1, Class 2, or Class 3) and divided into survey units with an explanation of the basis for division into survey units.
___ a description of the background reference areas and materials, if they will be used, and a justification for their selection.
___ a summary of the statistical tests that will be used to evaluate the survey results,
___ a description of scanning instruments, methods, calibration, operational checks, coverage, and sensitivity for each media and radionuclide.
___ for in-situ sample measurements made by field instruments, a description of the instruments, calibration, operational checks, sensitivity, and sampling methods with a demonstration that the instruments and methods have adequate sensitivity.
___ a description of the analytical instruments for measuring samples in the laboratory, calibration, sensitivity, and methods with a demonstration that the instruments and methods have adequate sensitivity;
___ a description of how the samples to be analyzed in the laboratory will be collected, controlled, and handled;
___ a description of the final status survey investigation levels and how they were determined
___ a summary of any significant additional residual radioactivity that was not accounted for during site characterization;
___ a summary of direct measurement results and/or soil concentration levels in units that are comparable to the DCGL and if data is used to estimate or update the survey unit;
___ a summary of the direct measurements or sample data used to both evaluate the success of remediation and to estimate the survey unit variance.

FINAL STATUS SURVEY REPORT

___ an overview of the results of the final status survey.
___ a discussion of any changes that were made in the final status survey from what was proposed in the Decommissioning Plan or other prior submittals.
___ a description of the method by which the number of samples was determined for each survey unit;

___ a summary of the values used to determine the numbers of sample and a justification for these values;

___ the survey results for each survey unit include:

- ___ the number of samples taken for the survey unit;
- ___ a map or drawing of the survey unit showing the reference system and random start systematic sample locations for Class 1 and 2 survey units and random locations shown for Class 3 survey units and reference areas;
- ___ the measured sample concentrations;
- ___ the statistical evaluation of the measured concentrations;
- ___ judgmental and miscellaneous sample data sets reported separately from the those samples collected for performing the statistical evaluation;
- ___ a discussion of anomalous data including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of $DCGL_w$.
- ___ a statement that a given survey unit satisfied the $DCGL_w$ and the elevated measurement comparison if any sample points exceeded the $DCGL_w$.

___ a description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity

___ if a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for final radiological surveys; and

___ if a survey unit fails, a discussion of the impact that the reason for the failure has on other survey unit information.

<u>FINANCIAL ASSURANCE</u>

COST ESTIMATE

___ a cost estimate that appears to be based on documented and reasonable assumptions;

CERTIFICATION STATEMENT

___ the certification statement is based on the licensed possession limits and the applicable quantities specified in 10 CFR 30.35, 40.36, or 70.25

___ licensee is eligible to use a certification of financial assurance and, if eligible, that the certification amount is appropriate.

FINANCIAL MECHANISM

___ the financial assurance mechanism supplied by the licensee or responsible party consists of one or more of the following instruments:

- ___ trust fund;
- ___ escrow account;
- ___ government fund;
- ___ certificate of deposit;
- ___ deposit of government securities;
- ___ surety bond;
- ___ letter of credit;
- ___ line of credit;
- ___ insurance policy;
- ___ parent company guarantee;
- ___ self guarantee;
- ___ external sinking fund;
- ___ statement of intent; or
- ___ by special arrangements with a government entity assuming custody or ownership of the site

___ the financial assurance mechanism is an originally signed duplicate.
___ the wording of the financial assurance mechanism is identical to the recommended wording provided in Appendix F,
___ for a licensee regulated under 10 CFR Part 72, a means is identified in the decommissioning plan for adjusting the financial assurance funding level over any storage and surveillance period;
___ the amount of financial assurance coverage provided by the licensee for site control and maintenance is at least as great as that calculated using the formula provided in this SRP

RESTRICTED USE/ALTERNATE CRITERIA

RESTRICTED USE

ELIGIBILITY DEMONSTRATION

___ a demonstration that the benefits of dose reduction are less than the cost of doses, injuries and fatalities; or
___ a demonstration that the proposed residual radioactivity levels at the site are ALARA

INSTITUTIONAL CONTROLS

___ a description of the legally enforceable institutional control(s) and an explanation of how the institutional control is a legally enforceable mechanism;
___ a description of any detriments associated with the maintenance of the institutional control(s);
___ a description of the restrictions on present and future landowners;
___ a description of the entities enforcing, and their authority to enforce, the institutional control(s);

___ a discussion of the durability of the institutional control(s);
___ a description of the activities that the entity with the authority to enforce the institutional controls may undertake to enforce the institutional control(s)
___ the manner in which the entity with the authority to enforce the institutional control(s) will be replaced if that entity is no longer willing or able to enforce the institutional control(s) (this may not be needed for Federal or State entities);
___ a description of the duration of the institutional control(s), the basis for the duration, the conditions that will end the institutional control(s) and the activities that will be undertaken to end the institutional control(s);
___ a description of the plans for corrective actions that may be undertaken in the event the institutional control(s) fail; and
___ a description of the records pertaining to the institutional controls, how and where will they will be maintained, and how the public will have access to the records.

SITE MAINTENANCE & FINANCIAL ASSURANCE

___ a demonstration that an appropriately qualified entity has been provided to control and maintain the site;
___ a description of the site maintenance and control program and the basis for concluding that the program is adequate to control and maintain the site;
___ a description of the arrangement or contract with the entity charged with carrying out the actions necessary to maintain control at the site;
___ a demonstration that the contract or arrangement will remain in effect for as long as feasible, and include provisions for renewing or replacing the contract;
___ a description of the manner in which independent oversight of the entity charged with maintaining the site will be conducted and what entity will conduct the oversight;
___ a demonstration that the entity providing the oversight has the authority to replace the entity charged with maintaining the site;
___ a description of the authority granted to the third party to perform, or have performed, any necessary maintenance activities;
___ unless the entity is a government entity, a demonstration that the third party is not the entity holding the financial assurance mechanism;
___ a demonstration that sufficient records evidencing to official actions and financial payments made by the third party are open to public inspection;
___ a description of the periodic site inspections that will be performed by the third party, including the frequency of the inspections.
___ a copy of the financial assurance mechanism provided by the licensee or responsible party; and,
___ a demonstration that the amount of financial assurance provided is sufficient to allow an independent third party to carry out any necessary control and maintenance activities[2].

OBTAINING PUBLIC ADVICE

___ a description of how individuals and institutions that may be affected by the decommissioning were identified and informed of the opportunity to provide advice to the licensee or responsible party;

___ a description of the manner in which the licensee obtained advice from these individuals or institutions;
___ a description of how the licensee provided for participation by a broad cross-section of community interests in obtaining the advice;
___ a description of how the licensee provided for a comprehensive, collective discussion on the issues by the participants represented;
___ a copy of the publicly available summary of the results of discussions, including individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants;
___ a description of how this summary has been made available to the public;
___ a description of how the licensee evaluated the advice, and the rationale for incorporating, or not incorporating, the advice from affected members of the community into the decommissioning plan.

DOSE MODELING AND ALARA DEMONSTRATION

___ a summary of the dose to the average member of the critical group when radionuclide levels are at the DCGL with institutional controls in place, as well as the estimated doses if they are no longer in place;
___ a summary of the evaluation performed pursuant to Section 7 of this SRP demonstrating that these doses are ALARA;
___ if the estimated dose to the average member of the critical group could exceed 100 mrem/yr (but would be less than 500 mrem/yr) when the radionuclide levels are at the DCGL, a demonstration that the criteria in 10 CFR 20.1403(e) have been met

ALTERNATE CRITERIA

___ a summary of the dose in TEDE(s) to the average member of the critical group when the radionuclide levels are at the DCGL (considering all man-made sources other than medical);
___ a summary of the evaluation performed pursuant to Section 7 of this SRP demonstrating that these doses are ALARA;
___ an analysis of all possible sources of exposure to radiation at the site and a discussion of why it is unlikely that the doses from all man-made sources, other than medical, will be more than 1 mSv/yr (100 mrem/yr);
___ a description of the legally enforceable institutional control(s) and an explanation of how the institutional control is a legally enforceable mechanism;
___ a description of any detriments associated with the maintenance of the institutional control(s);
___ a description of the restrictions on present and future landowners;
___ a description of the entities enforcing and their authority to enforce the institutional control(s);
___ a discussion of the durability of the institutional control(s);
___ a description of the activities that the party with the authority to enforce the institutional controls will undertake to enforce the institutional control(s)

- ___ a description of the manner in which the entity with the authority to enforce the institutional control(s) will be replaced if that entity is no longer willing or able to enforce the institutional control(s)
- ___ a description of the duration of the institutional control(s), the basis for the duration, the conditions that will end the institutional control(s) and the activities that will be undertaken to end the institutional control(s);
- ___ a description of the corrective actions that will be undertaken in the event the institutional control(s) fail; and
- ___ a description of the records pertaining to the institutional controls, how and where they will be maintained, and how the public will have access to the records.
- ___ a description of how individuals and institutions that may be affected by the decommissioning were identified and informed of the opportunity to provide advice to the licensee or responsible party;
- ___ a description of the manner in which the licensee obtained advice from affected individuals or institutions;
- ___ a description of how the licensee provided for participation by a broad cross-section of community interests in obtaining the advice;
- ___ a description of how the licensee provided for a comprehensive, collective discussion on the issues by the participants represented;
- ___ a copy of the publicly available summary of the results of discussions, including individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants;
- ___ a description of how this summary has been made available to the public; and,
- ___ a description of how the licensee evaluated advice from individuals and institutions that could be affected by the decommissioning and the manner in which the advice was addressed.

APPENDIX B

PHYSICAL SPECIFICATIONS

1. Physical Specifications:

a. <u>Paper size</u>
(1) Text pages: 8-1/2 x 11 inches.
(2) Drawings and graphics: 8-1/2 x 11 inches; however, a larger size is acceptable provided the finished copy when folded does not exceed 8-1/2 x 11 inches.

b. <u>Paper stock and ink</u>
Suitable quality in substance, paper color, and ink density for handling and reproduction by microfilming or image-copying equipment.

c. <u>Paper margins</u>
A margin of no less than 1 inch should be maintained on the top, bottom, and binding side of all pages submitted.

d. <u>Printing</u>
(1) Composition: text pages should be single spaced.
(2) Typeface and style: should be suitable for microfilming or image-copying equipment.
(3) Reproduction: may be mechanically or photographically reproduced. All pages of text should be printed on both sides and the image printed head to head.

e. <u>Binding</u>
Pages should be punched for standard 3-hole loose-leaf binders.

f. <u>Page numbering</u>
Pages should be numbered with the digits corresponding to the chapter followed by a hyphen and a sequential number, e.g., the third page of Section 4 should be numbered 4-3. Do not number the entire report sequentially.

g. <u>Table of contents</u>
A table of contents and an index of key items should be included.

2. Graphical Presentations

Graphical presentations such as drawings, maps, diagrams, sketches, and tables should be employed if the information may be presented more adequately or conveniently by such means. Due concern should be taken to ensure that all information so presented is legible, that symbols are defined, and that scales are not reduced to the extent that visual aids are necessary to interpret pertinent items of information. These graphical presentations should be located in the secti.on where they are primarily discussed. References used may appear either as footnotes to the page where discussed or at the end of each chapter.

3. Procedures for Updating or Revising Pages

Data and text should be updated or revised by replacing pages. The changed or revised portion on each page should be highlighted by a "change indicator" mark consisting of a bold vertical line drawn in the margin opposite the binding margin., The line should be of the same length as the portion actually changed. All pages submitted to update, revise, or add pages to the report should show the date of change and change or amendment number. A guide page listing the pages to be inserted and the pages to be removed should accompany the revised pages. When major changes or additions are made, a revised table of contents should be provided.

APPENDIX C

Technical Basis for Dose Modeling Evaluations

APPENDIX C

TECHNICAL BASIS FOR DOSE MODELING EVALUATION

CONTENTS

1.0 INTRODUCTION

1.1 Background

On July 21, 1997, the U.S. Nuclear Regulatory Commission (NRC) published a final rule on "Radiological Criteria for License Termination," in the Federal Register (62 FR 39058), which was incorporated as Subpart E to 10 CFR Part 20. In 1998 NRC staff developed a draft regulatory guide, *Demonstrating Compliance with the Radiological Criteria for License Termination* (DG-4006) (NRC, 1998), and a draft document *Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination* (NUREG-1549) (NRC, 1998a) in support of the final rule. In addition, staff developed a screening code "DandD" for demonstrating compliance with the dose criteria in Part 20, Subpart E.

On July 8, 1998, the Commission approved publication of the draft guidance, DG-4006, the draft NUREG-1549, and the DandD screening code for interim use for a 2-year period (i.e., from July 8, 1998, through July 7, 2000) (NRC, 1998b). In addition, the Commission directed staff to: (1) develop a standard review plan (SRP) for decommissioning, and provide the Commission with a timeline for developing the SRP; (2) maintain a dialogue with the public during the interim period; (3) address areas of excessive conservatism, particularly in the DandD screening code; (4) develop a more user-friendly format for the guidance, and (5) use a probabilistic approach to calculate the total effective dose equivalent to the average member of the critical group (NRC,1998b).

Staff has completed development of the SRP. Chapter 5 of the SRP addresses the staff's review of licensee's dose modeling to demonstrate compliance with the criteria in 10 CFR Part 20 Subpart E. This Technical Basis Document (herein referred to as theTBD) was developed by NRC staff as a technical information support document for performing the staff's evaluations of the licensee's dose modeling. It presents detailed technical approaches, methodologies, criteria, and guidance for staff reviewing dose modeling to demonstrate compliance with the dose criteria in 10 CFR Part 20, Subpart E. The TBD has been developed through an iterative process with the public including, licensees, Federal agencies, States, and other interested individuals. To support this process, NRC staff conducted seven public workshops and gave several presentations at national and international professional meetings, stakeholder meetings, Interagency Steering Committee on Radiation Standards (ISCORS) meetings, Conference of Radiation Control Program Directors (CRCPD) meetings, as well as presentations to the NRC's Advisory Committee on Nuclear Waste (ACNW). In addition, NRC staff posted the draft TBBD on the NRC Website and requested interested individuals to provide the NRC staff with comments on the draft TBD.

Over the past 2 years, staff has tested the DandD code for complex sites and addressed the issue of excessive conservatism in the DandD code. In addition, staff developed a new probabilistic DandD code (i.e.,DandD Version 2) to reduce the excessively conservative approach in the previous version of the DandD code. Further, staff developed RESRAD and RESRAD-BUILD probabilistic codes for site-specific analysis. Development of the probabilistic DandD and RESRAD/RESRAD-BUILD codes also responds to the Commission's direction to use a probabilistic approach to calculate the total effective dose equivalent to the average member of the critical group.

1.2 Brief Description and Scope

The TBD should be used, along with Chapter 5 of the SRP, “Dose Modeling Evaluation,” by staff reviewing a licensee’s analysis for demonstrating compliance with the dose criteria in 10 CFR 20, Subpart E. Each section of the TBD is summarized below.

Section 1.3 of the TBD presents the iterative approach in dose modeling and the decision framework methodology. Section 1.3 should help reviewers direct licensees to alternate options for more advanced dose assessments, based on additional site characterization or remedial actions to reduce the overall dose at the site.

Section 2 presents acceptable approaches, look-up tables, and screening models for evaluating a licensee’s demonstration of compliance with the dose criteria, using a screening methodology. Section 2 also discusses the attributes of screening and site-specific analysis, to evaluate the merits of both dose modeling approaches. Section 2 also identifies the criteria for qualification of the site for this screening approach.

Section 3 presents staff approaches for reviewing the conceptual representation of the radioactive source-term at the site. This section describes the areas of reviews pertaining to the existing radioactive material contamination and physical and chemical characteristics of the material. In addition, the section presents recommended approaches for source-term abstraction for the purpose of performing the dose analysis.

Section 4 focuses on areas of review and criteria for accepting modifications of pathways of the two generic critical group scenarios, the “resident farmer” and the “building occupancy” scenarios. Section 4 presents criteria for the staff’s review of a licensee’s justification for modifying default screening scenarios and associated pathways. It also presents approaches for establishing site-specific scenarios, critical groups, and/or sets of exposure pathways, based on specific land use, site restrictions, and/or site-specific physical conditions.

Section 5 provides approaches for developing site-conceptual models for dose analysis. This section presents approaches for the assimilation of data to establish a site conceptual model, via the linkage of the source-term with the critical group receptor and the use of applicable pathways and site-characterization data. It also presents approaches for employing applicable mathematical models to simulate and calculate the release and transport of contaminants from the source to the receptor. This section also presents discussions of the typical conceptual models used in the DandD and RESRAD codes. Additionally, the section provides information on the limitations of the DandD and RESRAD models and review areas to ensure compatibility of the site conceptual model with the conceptual models embedded in the DandD and RESRAD codes.

Section 6 presents approaches and criteria for staff acceptance of computer codes/models. Section 6 presents review aspects pertaining to codes/models specifications, testing, verification, documentation, and quality assurance/quality control (QA/QC) of the code used by the licensee. This section also addresses reviews applicable to embedded numerical models for the source-term, the exposure pathway models, the transport models, and the intakes or dose conversion models. The section also provides a discussion of the development of and a description of the DandD code, particularly the excessive conservatism of the Version 1 of the DandD code. It also describes approaches for the development of the probabilistic DandD, Version 2, and examples of DandD code application. Section 6 also presents a generic description of the deterministic RESRAD/RESRAD-BUILD codes and approaches for the development of the probabilistic RESRAD & RESRAD-BUILD codes. It also provides examples of the application and execution of the newly developed codes.

Section 7 describes approaches for the selection and modification of input parameters for dose modeling analysis. The section lists default parameter distributions, default distribution types, and default parameter distribution values for the probabilistic DandD, RESRAD, and RESRAD-BUILD codes.

Section 8 addresses the acceptable criteria for treating uncertainties in the dose modeling analysis. Issues pertaining to uncertainty and sensitivity are described and staff recommended approaches for the resolution of these issues are addressed. Policy positions are presented regarding approaches to uncertainty/sensitivity treatments and specific percentile dose-distribution selection for the screening and site-specific analysis. Staff review of input parameter distributions for Monte Carlo analysis and generic description of sensitivity analysis, including statistical techniques, are also described.

The TBD is intended for use by staff performing technical reviews of dose analysis methods and approaches as well as the reviews of employed codes/models and associated pathways and parameters by licensees to demonstrate compliance with the dose criteria in Part 20, Subpart E. The TBD may also be used by licensees as guidance for acceptable approaches or methodologies to conduct these dose modeling analysis. Further, the look-up tables and the newly developed codes/models may also be used by licensees, if applicable, for demonstrating compliance with the criteria in 10 CFR Part 20 Subpart E.

1.3 Dose Modeling and Decision Framework Methodology

NUREG-1549 provides a summary of the decision framework and methodology for conducting dose assessments in support of license termination decisions. It also provides three separate discussions to illustrate the phased and iterative nature of assessments as increasing complexity occurs. What follows is both a summary of the steps of the decision framework and a set of examples to help users walk through most of the features of dose modeling in the context of the decision support methodology.

Steps of the Decision Framework

Refer to Figure C1.1 (from NUREG-1549) while reviewing the following steps of the dose modeling framework (note that steps 6, 7 or 13 from NUREG-1549 are not discussed below):

Step 1: The first step in a dose assessment involves gathering and evaluating existing data and information about the site, including the nature and extent of contamination at the site. Often, minimal information is all that is needed for an initial screening analyses (e.g., a simple representation of the source of contamination). Specifically, information is needed to support the decision that the site is “simple” and is qualified for screening analysis (see Section 2). However, reviewers should use all information about the site that is readily available. This step also includes the definition of the performance objectives that must be met to demonstrate compliance with decommissioning criteria.

Step 2: This step involves defining the scenarios and pathways that are important and relevant for the site dose assessment (see Section 4). For all assessments using DandD, the NRC has already defined the generic scenarios and pathways for screening. For site-specific analysis, DandD and RESRAD/RESRAD-BUILD codes may be used, in addition to other codes. These codes should allow the user to both select, and de-select, exposure pathways, if these pathways are not considered relevant because of site-specific conditions (see Section 4).

Step 3: Once scenarios are defined and exposure pathways identified, a basic conceptual understanding of the system is developed, often based on simplifying assumptions regarding the nature and behavior of the natural systems (see Section 5). System conceptualization includes conceptual and mathematical model development and assessment of parameter uncertainty. Using DandD for generic screening, the NRC has pre-defined conceptual models for the scenarios along with default parameter distributions (based on NUREG/CR-5512, Volumes 1 and 3) (Kennedy and Strenge, 1992; Beyeler et al., 1999). For site-specific analysis, the DandD and/or RESRAD/RESRAD BUILD conceptual model can be used after verification that the site conceptual model is compatible with the conceptual model of the code used.

Step 4: This step involves the dose assessment or consequence analysis, based on the defined scenario(s), exposure pathways, models, and parameter distributions. For generic screening, reviewers can accept look-up table (see Section 2) and use the generic models and default parameter probability density functions (pdfs), simply by running DandD, with the appropriate site-specific source term, leaving all other information in the software unchanged. Site-specific assessments allow the user to use other codes and change pathways and parameter distributions, based on site -specific data and information. DandD and RESRAD/RESRAD-BUILD provide various plots and reports of the dose distribution, based on Monte Carlo sampling of the input distributions.

Step 5: This is the first major decision point in the license termination decision process. It involves answering the question of whether the dose assessment results from Step 4 demonstrate compliance with the dose criterion in 10 CFR 20, Subpart E. NRC has established the confidence required when interpreting the results from the probabilistic dose assessment. For instance, for screening analysis, licensees may need to demonstrate that the 90^{th} percentile value of dose is less than 0.25 milliSieverts per year (0.25 mSv/y) (25 millirem per year (25 mrem/y)). If the results are below the limit, the licensee proceeds with Steps 6 and 7 to demonstrate that the “as low as is reasonably achievable” (ALARA) requirements in Subpart E have been met. If the ALARA requirements are satisfied the licensee initiates the license termination process defined by the NRC in other guidance documents. Note that the DandD or RESRAD codes do not involve or automate these steps.

If the results are ambiguous or clearly exceed the performance objective, then the licensee must proceed to Steps 8 and 9.

Step 8: Full application of the decision framework involves defining all possible options the licensee might address to defend a final set of actions needed to demonstrate compliance with license termination criteria. Options may include acquiring more data and information about the site and source(s) of contamination, to reduce uncertainty about the pathways, models, and parameters, and thus reduce the calculated dose; reducing actual contamination through remediation actions; reducing exposure to radionuclides through implementation of land-use restrictions; or some combination of these options.

DandD and RESRAD/RESRAD-BUILD codes provide a sensitivity analysis module that allows the licensee to identify sensitive parameters (e.g., those having the greatest impact on dose assessment results), and to explore potential reductions in the uncertainty associated with those parameters. Note that one option may include elimination of exposure pathways caused by site-specific considerations.

Step 9: All the options identified in Step 8 are analyzed and compared in order to optimize selection of a preferred set of options to go forward with. This options analysis may consider the cost of implementation, the likelihood of success (and the expected costs associated with success or failure to achieve the desired results when the option is implemented), timing considerations and constraints, and other quantitative and/or qualitative selection criteria. The DandD and RESRAD software make it possible to display the potential impact, on the dose modeling results, through selective truncation of the uncertainty bounds of the input parameters.

Step 10: The activities in Steps 8 and 9 provide information for licensees to choose the preferred decommissioning option based on considerations of cost, the likelihood of success, timeliness, and other considerations. Based on the results of the DandD and RESRAD/RESRAD-BUILD sensitivity analysis, for example, a licensee may identify one or more parameters that may be modified, based on the acquisition of site-specific information and data. If new data can reduce the uncertainty associated with sensitive parameters, the licensee may be able to defend a new calculated dose that meets the license termination criteria. If no viable options exist at this time, the licensee may decide to defer actions (Step 13) until circumstances allow re-visiting license termination.

Step 11: Under Step 11, the preferred option is implemented. The licensee commits resources to obtain the information necessary to support revisions to the parameters identified in Steps 8 and 9.

Step 12: Once data are successfully obtained, the affected parameters for the pre-defined models are revised as appropriate. Also, data may support elimination of one or more of the exposure pathways in the pre-defined scenarios. DandD and RESRAD/RESRAD-BUILD codes provide very simple and straightforward modification of the pathways and parameters of interest. The software also includes, in “Help,” full documentation of the original basis for the parameter distributions, references, and sources of information the licensee might need, to defend modifications, based on actual site-specific data and circumstances.

Once the pathways and parameters are revised, the licensee would re-visit Steps 4 and 5 to determine the impact of the revisions on demonstrating compliance with the performance objectives. If met, the licensee proceeds to Steps 6 and 7. If the performance objective is still exceeded, the licensee returns to Steps 8 and 9 to analyze remaining options to proceed.

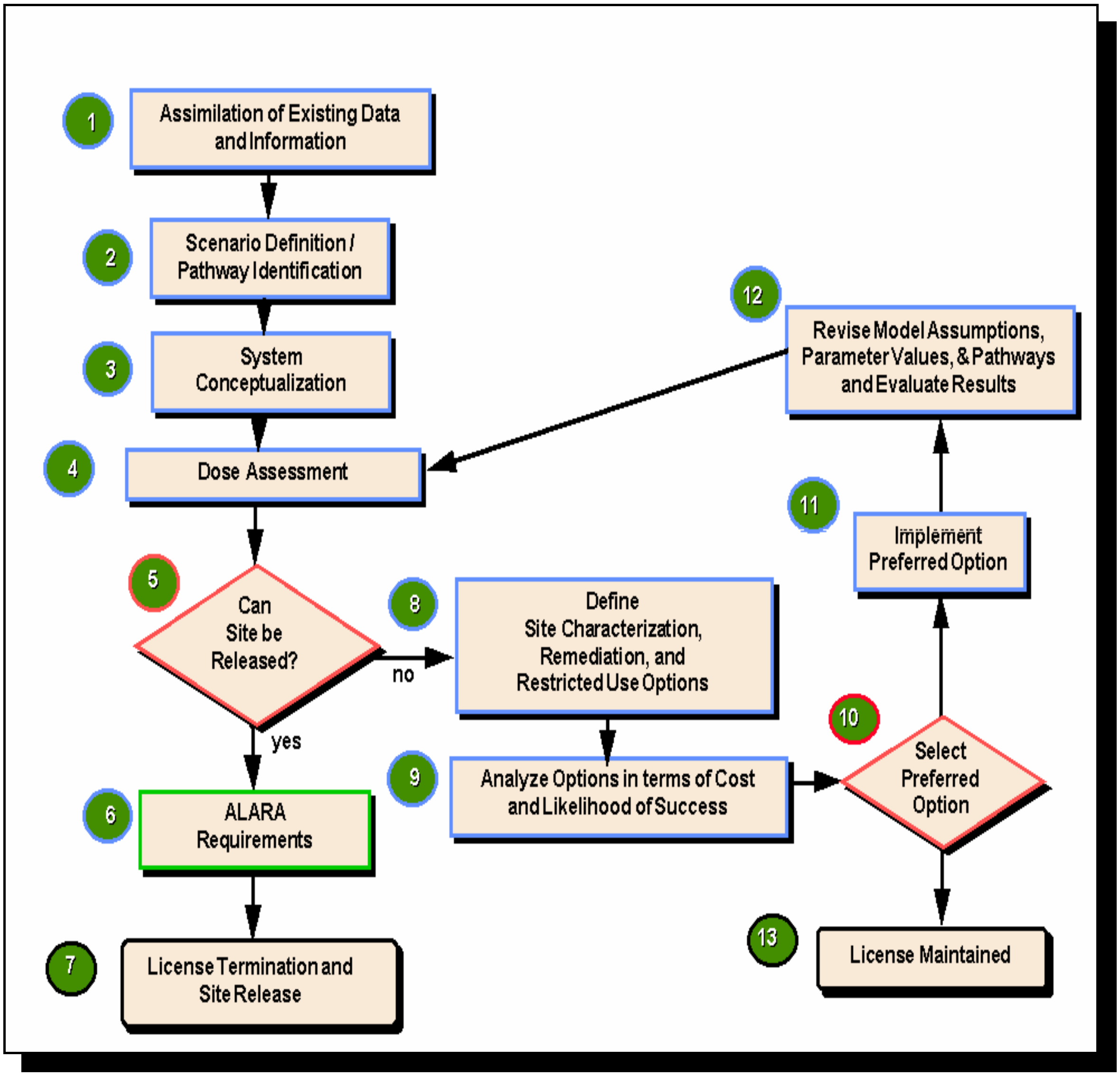

Figure C1.1 Decommissioning and License Termination Framework.

2.0 CRITERIA FOR CONDUCTING SCREENING

2.1 Introduction

This section pertains to the staff's review of a licensee's demonstration of compliance with the dose criteria in Part 20, Subpart E, using a screening approach dose analysis. Staff review of the screening analysis should be performed using one or more of the currently available screening tools: (1) a look-up table for common beta-/gamma- emitting radionuclides for building surface contamination (63 FR 64132, Nov. 18, 1998); (2) a look-up table for common radionuclides for soil surface contamination (64 FR 68395, December 7, 1999); and (3) screening levels derived using DandD, Version 2.0, for the specific radionuclide(s) using the code's default parameters. Other tools for performing a screening analysis might become available in the future, depending on further staff efforts to develop additional look-up tables. Other alternate screening approaches or procedures might be appropriate, based on the merits and level of conservatism of the alternate screening approaches or procedures.

A screening analysis is usually conducted for simple sites with building surface (e.g., non-volumetric) contamination and/or with surficial soil [approximately 6 in (15 cm)] of residual radioactivity. Simple and conservative models/codes and parameters, under generic scenarios and default site conditions, are usually employed to define the screening derived concentration guideline levels (DCGLs) equivalent to the dose criteria. Because of the conservative nature of the screening analysis approach, the screening DCGLs are expected to be more restrictive than the site-specific DCGLs. Nevertheless, staff should be aware that screening analysis may save licensees time and effort by reducing the amount of site characterization, modeling analysis, and reviews that might be needed when using a site-specific analysis approach.

To conduct a screening analysis review, staff needs to first make a generic assessment and evaluation of a licensee's justification that the site is qualified for screening. In addition, staff should review the tools (e.g., models, codes, and calculations) and embedded assumptions used in derivation of the screening DCGLs. This section addresses the major issues that staff may encounter in the generic screening analysis reviews, and includes recommendations of approaches for addressing and resolving these issues.

2.2 Issues in Performing Screening Analysis

The major issues associated with the screening analysis that staff may encounter include: (1) the definition of screening and the transition from a screening to a site-specific analysis; (2) qualification of the site for screening, in terms of site physical conditions and compatibility with the modeling code's assumptions and default parameters; and, (3) the acceptable screening tools (e.g., code, look-up tables), approaches, and parameters that staff can use to translate the dose into equivalent screening concentration levels. Each one of these issues is discussed in the following subsections.

2.2.1 Definition of Screening and the Transition from Screening to Site-Specific Analysis

Staff may encounter some inconsistencies regarding the definition of the term “screening” in dose analysis which may cause confusion regarding the transition from a screening to a site-specific analysis. These inconsistencies become more apparent when dividing screening approaches into multiple levels (NCRP, 1996, 1999). In some cases screening and site-specific terms are mixed, and the term “site-specific screening” is used (Kennedy and Strenge, 1992). In certain cases screening is categorized on the type of models used (e.g., simple and conservative models vs. more advanced and complex models) and the extent of data and information needed to support the dose analysis. Recommended approaches for resolving this issue are presented in Section 2.3.1.

2.2.2 Qualification of the Site for Screening

Staff should be aware that a screening analysis, for demonstrating compliance with the dose criteria in Part 20, Subpart E, may not be applicable for certain sites because of the status of contaminants (e.g., location and distribution of radionuclides), or because of site-specific physical conditions. Therefore, staff must assess the site source-term (e.g., radionuclide distribution) characteristics to ensure consistency with the source-term assumptions in the screening model/code used (e.g., DandD). In addition, reviewers should determine if specific physical conditions at the site would invalidate the model and code assumptions associated with the screening code/model. Staff should review the selected screening parameters and pathways to ensure that they are conservative and consistent with the parameters and pathways of the DandD code. Further, staff may determine that there could be conditions, at the specific site, that cannot be handled by the simple screening model, because of the complex nature of the site, or because of the simple conceptual model in the DandD screening code. Staff-recommended approaches to address and resolve this screening issue are presented in Section 2.3.2.

2.2.3 Screening Tools

In the past, it may not have been clear what screening tools the NRC believes is acceptable. Some may believe that using simple, common codes (other than DandD), with their deterministic default parameters may be acceptable to derive the desired screening DCGLs. Others may believe that use of any look-up tables published by certain scientific committees or authorities may be used to convert concentration levels directly into doses for purposes of complying with Part 20, Subpart E. Questions regarding use of the DandD code for screening, particularly whether modification of input default parameters is acceptable for screening have also been raised. The staff has developed approaches and recommendations to address these issues and they presented in Subsection 2.3.3.

2.3 Recommended Approaches

2.3.1 Screening Definition and Approaches for the Transition from Screening to Site-Specific Analysis

Within the context of this SRP, staff should consider the definition of screening as the process of developing derived concentration guideline levels (DCGLs) at a site using either NRC's look-up tables (63 FR 64132, November 18, 1998 ; 64 FR 68395, December 7, 1999) or the latest version (e.g., Version 2.0) of the DandD code developed by the NRC to perform the generic screening analysis. Staff may also use the latest version of the DandD code, without modification of the default values, to derive screening values. However, because the currently available version of DandD (Version 1) is overly conservative, and DandD Version 2 is under development, staff may use, in the interim, the screening values listed in Tables 5.19 and 6.91 of NUREG/CR-5512, Volume 3 (Beyeler, et al., 1999). Specifically, staff may use Table 5.19 (P_{crit} = 0.90) for the building-occupancy scenario screening values and Table 6.91 (P_{crit} = 0.1) for the residential scenario screening values. In addition, when using the DandD code, the screening process would also require the use of the default assumptions, scenarios, and default parameters of the DandD code. It should be noted that staff may also develop additional look-up tables for the common alpha-emitters for building surfaces (based on the DandD code and modification of sensitive parameters) or may modify current look-up tables. In addition, staff may also consider the use of other screening tools (e.g., other look-up tables or other conservative codes/models) after evaluation and comparison of the level of conservatism, compatibilities, and consistencies of these tools with the DandD code default conditions and with site-specific conditions. Staff may evaluate the possible use of other screening tools on a case-by-case basis. In general, staff should recognize that when licensees select other approaches or models for the dose analysis, or modify the DandD code default parameters, scenarios, and/or pathways, they would be considered as entering into the site-specific analysis mode. Therefore, staff should not categorize screening into different levels, because the specific criteria for each screening level and the dose evaluation approach for a specific screening level are difficult to establish.

Staff should recognize the advantage of selecting a screening approach for demonstrating compliance with the dose criteria, because it requires minimum justification, no characterization, and minimum staff review. On the other hand, for site-specific analysis, staff would require the licensee to provide justifications and site-specific information, as necessary, to support changes in parameters, or changes of codes/models and default assumptions. Table C2.1 provides a brief summary of attributes and merits of each screening and site-specific analysis approach.

As noted in Table C2.1, the models, scenarios, and parameters used in screening are intended to be conservative, because the lack of information about a site warrants the use of conservative models and default conditions to ensure that the derived dose is not under-estimated. In other words, the screening analysis is intended to overestimate the dose, to ensure that, for 90 percent of the screening cases, the derived dose is not under-estimated. In performing screening analysis, staff should recognize additional significant differences between screening and site-specific analysis, which is the basis for the selection of the compliance dose regarding treating uncertainties. In the screening analysis, the 90th percentile of the dose distribution is used, whereas the peak of the mean dose over time (e.g., 1000 years) or the mean of the peak dose distribution may be used in the site-specific analysis. In summary, staff should note that there are two modes of dose modeling analysis: screening and site-specific. As soon as default parameters are changed, source-term conditions are modified, and/or different models/codes are used, a transition from screening to site-specific analysis would be indicated.

2.3.2 Qualification of the Site for Screening

When using the screening approach for demonstrating compliance with the dose criteria in Part 20, Subpart E, licensees need to demonstrate that the particular site conditions (e.g., physical and source-term conditions) are compatible and consistent with the DandD model assumptions (Kennedy and Strenge, 1992). In addition, the default parameters and default scenarios/pathways must also be used in the screening dose analysis. Therefore, reviewers should examine the site conceptual model, the generic source-term characteristics,

Table C2.1 Attributes of Screening and Site-Specific Analysis

Attribute	Screening	Site-Specific
Models/Codes	DandD Version 2.0 (Others may be accepted)	Any model/code compatible with the site and approved by staff
Scope of Application	Only for sites qualified for screening	Any site
Parameters	DandD default parameters	Site-specific and/or surrogates with justification
Scenarios/pathways	DandD default scenarios/pathways	Scenarios/pathways may be modified, based on site condition.
Basis of dose Selection & Uncertainty	The peak dose at the 90^{th} percentile of the peak dose distribution within 1000 years	Peak of the mean annual doses within 1000 years, or mean of the peak dose distribution

and other attributes of the sites, to ensure that the site is qualified for screening.

Staff should verify that the following site conditions exist:

Building Surface Contamination:

1. The contamination on building surfaces (e.g., walls, floors, ceilings) should be surficial and non-volumetric [e.g., $\leq$ 0.4 in (10 mm)].

2. Contamination on surfaces is mostly fixed (not loose), with the fraction of loose contamination not to exceed 10 percent of the total surface activity.
3. The screening criteria may are not being applied to surfaces such as buried structures (e.g., drainage or sewer pipes) or mobile equipment within the building; such structures and buried surfaces will be treated on a case-by-case basis.

Surface Soil Contamination:

1. The initial residual radioactivity (after decommissioning) is contained in the top layer of the surface soil [e.g., approximately 6 in (15 cm)].
2. The unsaturated zone and the groundwater are initially free of contamination.
3. The vertical saturated hydraulic conductivity at the specific site is greater than the infiltration rate.

After verifying that a site qualifies for screening, staff may compare the actual level of contamination at the site with the screening levels published in the NRC's look-up tables or may use the latest version of the DandD code.

Questions have also been raised about the appropriateness of using a screening analysis at sites with contaminated areas larger than the current default cultivated area [e.g., 2400 m^2 (25,800 ft^2)]. Staff evaluated the effect of a large contaminated area on the derived screening dose and determined that this effect is trivial for sites with the dominant dose arising from direct exposure or inhalation. However, for sites with a significant dose contribution associated with the ingestion pathway (specifically ingestion associated with the drinking water and irrigation pathways), this effect could be appreciable. Staff determined that, for sites with contaminated areas of 6000 - 7200 m^2 (64,600 - 77,500 ft^2) the dose may be underestimated under worst-case conditions by a factor of 2 to 3. However, the staff analysis showed that, if users select the site-specific analysis, the dose would be far less than the estimated dose. For sites with areas larger than 7200 m^2 (77,500 ft^2), this effect is not appreciable. Therefore, staff should accept screening analysis for relatively large-area sites, because they likely to be conservative and may be counted among the 10 percent of the sites where the dose may be slightly underestimated. In addition, because of the conservative assumptions of the DandD code, it is more likely that the derived dose, based on the use of other codes or the use of a site-specific analysis, would be far less than the derived dose using these default conditions. In summary, assuming that the site is qualified for screening based on the above listed criteria, the screening approach would be accepted for sites with areas larger than the default cultivated area [i.e., 2400 m^2 (25,800 ft^2).

It should be noted that staff should also evaluate complex site conditions that may disqualify the site for screening. Examples of such complex site conditions may include: highly fractured formation, karst conditions, extensive surface-water contamination, and/or a highly non-homogeneous distribution of contamination. Therefore, reviewers should ensure that the site meets the definition of a "simple site" to qualify for screening.

2.3.3 Acceptable Screening Tools

The currently available screening tools that staff should accept for a screening analyses include:

1. A look-up table (Table C2.2) for common beta-/gamma- emitting radionuclides for building-surface contamination (63 FR 64132, November 18, 1998).

2. A look-up table (Table C2.3) for common radionuclides for soil surface contamination (64 FR 68395, December 7, 1999).

   The screening values in Tables C2.2 and C2.3 are intended for single radionuclides. For radionuclides in mixtures, the "sum of fractions" rule should be used. These values were derived using DandD screening methodology based on selection of the 90th percentile of the output dose distribution for each specific radionuclide (or radionuclide with the specific decay chain). Behavior parameters were set at the mean of the distribution of the assumed critical group. The metabolic parameters were set at the Standard Man or at the mean of the distribution for an average man. **NOTE: For a chain of radionuclides, that is, a radionuclide with its progeny present at equilibrium, the "+C" values of Table C2.3 must be interpreted carefully. As described in footnote 3 to Table C2.3, these +C values are concentrations of the parent radionuclide only, but account for dose contributions from the complete chain of progeny in equilibrium with the parent radionuclide.**

3. A look-up table for radionuclides for building-surface contamination from NUREG/CR-5512, Volume 3.

   Some radionuclides are not included in Table C2.2. Additional radionuclides are listed in the equivalent table for building-surface contamination, Table 5.19, of NUREG/CR-5512, Volume 3. From this table, the values for p_{crit} = 0.90 may be used to determine acceptable screening values. **NOTE: For chains of radionuclides, the +C values of Table 5.19 are presented differently from the values of Table C2.2 and must be interpreted carefully. The +C values in Table 5.19 of NUREG/CR-5512, Volume 3, are concentrations of all radionuclides in the decay chain (at equilibrium) summed up. Though the values from the two sources are equivalent (when correctly interpreted), the values from Table 5.19 are different numerically from those of Table C2.2.**

4. A look-up table for radionuclides for soil surface contamination from NUREG/CR-5512, Volume 3.

   Some radionuclides are not included in Table C2.3. Additional radionuclides are listed in the equivalent table for soil surface contamination, Table 6.91, of NUREG/CR-5512, Volume 3. From this table, the values for p_{crit} = 0.10 may be used to determine acceptable screening values. **NOTE: For chains of radionuclides, the +C values of Table 6.91 are presented differently from the +C values of Table C2.3, and must be interpreted carefully. As described for Table 5.19 above, the +C values in Table 6.91 of NUREG/CR-5512, Volume 3, are concentrations of all radionuclides in the decay chain (at equilibrium) summed up.**

5. Screening levels derived using DandD Version 2.0 for the specific radionuclide and using code default parameters.

In August 1998, NRC staff issued DandD, Version 1.0 for screening and simple site-specific analysis. Staff, and users (through public workshops), have identified several areas where DandD, Version 1, may be overly conservative. One such conservatism is the methodology used for establishing a single default parameter set for all radionuclides listed in the DandD code. That is, if the default parameter set were tailored for each specific radionuclide, the dose calculated using the DandD model would, in most cases, be lower. A detailed discussion of the way the default parameters were selected is included in NUREG/CR-5512, Volume 3, and the conservatism of DandD code Version 1 is discussed in Section 6. Therefore, executing DandD, Version 1 for deriving the screening DCGL, will produce, for some radionuclides, anomalies from the artifact in selection of the default parameter set. Staff developed Version 2.0 of the DandD code to minimize this artifact and reduce the over-conservatism in the DandD, Version 1.0 approach and staff should use DandD Version 2.0 for screening rather than version 1.0. Similarly, version 2.0 is more appropriate for site-specific analysis of simple sites. Staff may access the DandD code at the website: *http: //techconf.llnl.gov*.

6. Potential use of other tools or approaches for screening.

The current staff position is to limit screening to the look-up tables developed by the NRC and the execution of the latest version of DandD code with the default parameters. As indicated above, staff may develop additional look-up tables or modify the screening tables, based on refining certain sensitive parameters. Staff is evaluating the possibility of using other simple codes/models for screening, such as the probabilistic RESRAD and RESRAD-BUILD codes currently under development. Furthermore, staff may evaluate requests by licensees to use other look-up tables developed by specific consensus professional or technical groups or authorities. Staff will examine the screening approaches, methodologies, scenarios, and assumptions in these other approaches to ensure compatibility with the current screening methodology using DandD. Staff will also assess the site conditions to ensure that the screening analysis is appropriate for the site. In certain cases, staff may need to examine and compare the default screening parameters with the site-specific conditions. The behavior, metabolic, and physical parameters used for the screening analysis are listed in Section 7 of the TBD, to facilitate this comparison.

Table C2.2 Acceptable License Termination Screening Values of Common Radionuclides for Building-Surface Contamination

Radionuclide	Symbol	Acceptable Screening Levels[1] for Unrestricted Release (dpm/100 cm^2)[2]
Hydrogen-3 (Tritium)	^3H	1.2E+08

Carbon-14	^{14}C	3.7E+06
Sodium-22	^{22}Na	9.5E+03
Sulfur -35	^{35}S	1.3E+07
Chlorine-36	^{36}Cl	5.0E+05
Manganese-54	^{54}Mn	3.2E+04
Iron-55	^{55}Fe	4.5E+06
Cobalt-60	^{60}Co	7.1E+03
Nickel-63	^{63}Ni	1.8E+06
Strontium-90	^{90}Sr	8.7E+03
Technetium-99	^{99}Tc	1.3E+06
Iodine-129	^{129}I	3.5E+04
Cesium-137	^{137}Cs	2.8E+04
Iridium-192	^{192}Ir	7.4E+04

[1]Screening levels are based on the assumption that the fraction of removable surface contamination is equal to 0.1. For cases when the fraction of removable contamination is undetermined or higher than 0.1, users may assume, for screening purposes, that 100 percent of surface contamination is removable, and therefore the screening levels should be decreased by a factor of 10. Alternatively, users having site-specific data on the fraction of removable contamination, based on site-specific resuspension factors, (e.g., within 10 percent to 100 percent range) may calculate site-specific screening levels using DandD Version 2.

[2]Units are disintegrations per minute (dpm) per 100 square centimeters (dpm/100 cm^2). One dpm is equivalent to 0.0167 becquerel (Bq). Therefore, to convert to units of Bq/m^2 multiply each value by 1.67. The screening values represent surface concentrations of individual radionuclides that would be deemed in compliance with the 0.25 mSv/yr (25 mrem/yr) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the “sum of fractions” rule applies; see Part 20, Appendix B, Note 4.

Table C2.3 Interim Screening Values[1] (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels

Radionuclide	Symbol	Surface Soil Screening Values[2]
Hydrogen-3	^{3}H	1.1 E+02
Carbon-14	^{14}C	1.2 E+01
Sodium-22	^{22}Na	4.3 E+00
Sulfur-35	^{35}S	2.7 E+02
Chlorine-36	^{36}Cl	3.6 E-01
Calcium-45	^{45}Ca	5.7 E+01
Scandium-46	^{46}Sc	1.5 E+01
Manganese-54	^{54}Mn	1.5 E+01
Iron-55	^{55}Fe	1.0 E+04
Cobalt-57	^{57}Co	1.5 E+02
Cobalt-60	^{60}Co	3.8 E+00
Nickel-59	^{59}Ni	5.5 E+03
Nickel-63	^{63}Ni	2.1 E+03
Strontium-90	^{90}Sr	1.7 E+00
Niobium-94	^{94}Nb	5.8 E+00
Technetium-99	^{99}Tc	1.9 E+01
Iodine-129	^{129}I	5.0 E-01
Cesium-134	^{134}Cs	5.7 E+00
Cesium-137	^{137}Cs	1.1 E+01
Europium-152	^{152}Eu	8.7 E+00
Europium-154	^{154}Eu	8.0 E+00
Iridium-192	^{192}Ir	4.1 E+01
Lead-210	^{210}Pb	9.0 E-01
Radium-226	^{226}Ra	7.0 E-01
Radium-226 + C[3]	^{226}Ra + C	6.0 E-01
Actinium-227	^{227}Ac	5.0 E-01
Actinium-227 + C	^{227}Ac + C	5.0 E-01

Table C2.3 Interim Screening Values[1] (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels

Radionuclide	Symbol	Surface Soil Screening Values[2]
Thorium-228	^{228}Th	4.7 E+00
Thorium-228 + C[3]	^{228}Th + C	4.7 E+00
Thorium-230	^{230}Th	1.8 E+00
Thorium-230 + C	^{230}Th + C	6.0 E-01
Thorium-232	^{232}Th	1.1 E+00
Thorium-232 + C	^{232}Th + C	1.1 E+00
Protactinium-231	^{231}Pa	3.0 E-01
Protactinium-231 + C	^{231}Pa + C	3.0 E-01
Uranium-234	^{234}U	1.3 E+01
Uranium-235	^{235}U	8.0 E+00
Uranium-235 + C	^{235}U + C	2.9 E-01
Uranium-238	^{238}U	1.4 E+01
Uranium-238 + C	^{238}U + C	5.0 E-01
Plutonium-238	^{238}Pu	2.5 E+00
Plutonium-239	^{239}Pu	2.3 E+00
Plutonium-241	^{241}Pu	7.2 E+01
Americium-241	^{241}Am	2.1 E+00
Curium-242	^{242}Cm	1.6 E+02
Curium-243	^{243}Cm	3.2 E+00

[1]These values represent surficial surface soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y (0.25 mSv/y) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies; see Part 20, Appendix B, Note 4.

[2]Screening values are in units of (pCi/g) equivalent to 25 mrem/y (0.25 mSv/y). To convert from pCi/g to units of becquerel per kilogram (Bq/kg) divide each value by 0.027. These values were derived using DandD screening methodology (NUREG/CR-5512, Volume 3). They were derived based on selection of the 90th percentile of the output dose distribution for each specific radionuclide (or radionuclide with the specific decay chain). Behavioral parameters were set at the mean of the distribution of the assumed critical group. The metabolic parameters were set at "Standard Man" or at the mean of the distribution for an average man.

[3]"Plus Chain (+C) " indicates a value for a radionuclide with its decay progeny present in equilibrium. The values are concentrations of the parent radionuclide, but account for contributions from the complete chain of progeny in equilibrium with the parent radionuclide (NUREG/CR-5512 Volumes 1, 2, and 3).

3.0 SOURCE-TERM ABSTRACTION

3.1 Introduction

Source-term abstraction is the process of developing a conceptual representation of the radioactive source at a site or facility (hereafter referred to collectively as “site”). Typically, the radiological conditions at a site proposed for decommissioning are relatively complex. Source-term abstraction is necessary to allow the detailed radiological characterization of the site to be incorporated into the mathematical and computer models that are used to estimate radiological impacts, such as dose. The abstraction process involves generalizing the radiological characteristics across the site to produce a simplified representation that will facilitate the modeling of radiological impacts. The conceptual representation of the source developed in the abstraction process, however, should not be simplified to the extent that radiological impacts are significantly underestimated or unrealistically overestimated.

As discussed in SRP Module 5, source-term abstraction serves as the starting point for the dose modeling process. The conceptual abstraction of the source term is combined with the physical characteristics of the site and characteristics of the critical group receptor to develop the conceptual model for the site. This conceptual model provides the basis for identifying applicable exposure scenarios, pathways, and selection of computer models. These other elements of dose modeling are discussed in subsequent sections of this document.

SRP Module 4 discusses the information the licensee is expected to provide regarding the existing radiological characterization of the site. The licensee is expected to provide a description of the types, levels and extent of radioactive material contaminated at the site. This will include contamination in all media, including buildings, systems and equipment, surface and subsurface soil, and surface and subsurface groundwater. The source-term abstraction should be based on the characterization of the radiological status reviewed under SRP Module 4 (e.g., process historical development, records of leakage or disposal). The licensee should explicitly relate the information provided in the discussion of radiological status of the site with the discussion of source-term abstraction. The reviewer should be able to clearly interpret the relationship.

Generally, in the source-term abstraction process, the licensee may focus on several specific elements of the source term:

1. The licensee should identify the radionuclides of concern. This should be taken directly from the description of the radiological status of the site. The radionuclides should be identified based on pre-remediation radiological status. All radionuclides potentially present at the site should be included, so that their presence or absence may be verified during the final status survey.

2. The licensee should describe the physical/chemical form of the contaminated media *anticipated at the time of final status survey and site release*. The licensee should indicate whether the residual contamination will be limited to building surfaces and/or surface soil, or will involve other media, such as subsurface soil, debris or waste materials (e.g., sludge, slag, tailings), or groundwater and surface water.

3. The licensee may need to delineate the spatial extent of the residual contamination *anticipated at the time of final status survey and site release*. The delineation of the spatial extent will include a description of areal extent of radionuclides throughout the site and, for soil contamination, the vertical extent of radionuclides below the ground surface. The delineation of spatial extent and depth will establish the source areas and volumes. Depending on the presence of specific radionuclides, source areas and volumes may be radionuclide-specific.

4. Finally, the licensee may need to define the distribution of each radionuclide throughout the delineated source areas and volumes *anticipated at the time of final status survey and site release*. The distribution of a radionuclide through the source should be defined in terms of representative volumetric or areal concentrations. In addition, for volumetrically contaminated soil, the licensee may provide an estimate of total radioactivity of each radionuclide.

5. The licensee needs to define sources in groundwater or surface water, if any, based on environmental monitoring and sampling of aquifers and surface water bodies. A site with groundwater or surface water contamination may be categorized as “complex” and will require more advanced dose modeling analysis.

In the source-term abstraction process, the licensee will always need to address the first two of these elements. Whether the licensee needs to address the other elements depends on the objective of the licensee’s dose modeling. This is discussed below in Section 3.3.

3.2 Issues Associated with Source-Term Abstraction

The level of effort that a licensee expends to develop a conceptualization of a source term should be commensurate with the licensee’s approach to demonstrating compliance with the release criterion. Also, the focus should be on the source-term characteristics anticipated to exist at the site at the time of final status survey and release, after any planned remediation.

If a licensee plans to use the screening DCGLs published by the NRC in the *Federal Register*, a licensee should only have to identify the radionuclides that may be present at the site, and demonstrate that the conditions at the site meet the prerequisites for using the screening values [i.e., residual contamination is limited to building surfaces or the uppermost 15 to 30 cm (6 to 12 in.) of surface soil and no contamination of groundwater or surface water]. The licensee’s source-term abstraction would not have to address issues such as existing radiological conditions, areal and volumetric extent of residual contamination, or spatial variability or radiological conditions for such sources. This is discussed further in Section 3.3.

If a licensee anticipates that residual contamination will be limited to building surfaces or surface soils at the time of final status survey, but considers the published DCGLs overly restrictive, the licensee may develop site-specific DCGLs. In this case, the licensee would most likely have to delineate the anticipated areal extent of residual contamination. However, the licensee would not have to discuss the anticipated spatial variability of radionuclide concentrations within the anticipated area of residual contamination.

A licensee will have to provide a site-specific dose assessment if the contamination the licensee intends to leave at the site is not limited to building contamination or surface soil. In this case, the licensee would have to delineate the spatial extent (laterally and vertically) of the contamination, and would provide a discussion of the spatial variability of the physical, chemical, and radiological characteristics of the contaminated media.

Ideally, the source characteristics at a site would be relatively uniform, justifying simplified abstraction. However, this is generally not the case. Issues may arise when the residual contamination projected at a site at the time of release falls short of the ideal case. These issues may include the following:

1. Spatial extent
   - Limited areal extent of residual contamination
   - Irregular areal shape
   - Varying depth of contamination in soil

2. Spatial variability
   - Non-uniform distribution of radioactivity throughout a site
   - Limited areas of relatively elevated radionuclide concentrations
   - Multiple non-contiguous areas of residual contamination
   - Non-uniform physical and chemical characteristics

The following approach to source-term abstraction addresses most of these issues. Others (such as irregular areal shape) are best addressed by appropriate selection of computer codes.

3.3 Approach to Source-Term Abstraction

A licensee's approach to source-term abstraction will depend on the objective of the dose modeling presented in the decommissioning plan. Generally, the licensee's dose modeling will have one of the following objectives:

1. Develop DCGLs commensurate with demonstrating compliance with the dose-based release criterion, and then demonstrate through final status survey that residual radioactivity concentrations at the site are below the DCGLs.

2. Assess dose associated with actual concentrations of residual radioactivity distributed across the site to determine whether the concentrations will result in a dose below the regulatory dose criterion.

The first objective is where the licensee intends to demonstrate that, at the time of final status survey before release, residual radionuclide concentrations across the site are below a pre-specified concentration limit with some pre-specified degree of confidence. The design of the final status survey would be based on the proposed DCGLs, in accordance with the "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (NUREG-1575, NRC, 1997). This approach is limited to building-surface and surface-soil contamination. The MARSSIM process does not require that the licensee incorporate information regarding the existing (i.e., pre-remediation or pre-final status survey) spatial distribution of radioactivity into the source-term abstraction. The identification of DCGLs may involve site-specific model and parameter assumptions, or may use “screening” analyses.

The second objective is where the licensee intends to assess potential radiation doses that may result from specified levels of radioactive material. The licensee may intend to leave various quantities of radioactively contaminated material on the site after release (i.e., residual contamination). The contaminated material may not be limited to building surfaces or surface soils, but may include contaminated subsurface soil, debris, and waste. The licensee’s dose modeling should demonstrate that the residual contamination should not result in radiation doses in excess of applicable regulatory limits. This modeling would be site-specific. Most likely, this modeling objective would require that the licensee incorporate information regarding both the spatial extent and spatial variability of radioactivity into the source-term abstraction.

Table C3.1 summarizes the approach to source-term abstraction that the licensee should adopt, depending on the licensee’s dose modeling objective and whether the licensee is providing screening or site-specific analyses. This table can serve as an index for the reviewer of the licensee’s source-term abstraction. Source-term abstraction, with respect to identifying DCGLs (the first objective), is discussed in Section 3.3.1. Source-term abstraction, with respect to assessing doses from specified levels of radioactive material (the second objective), is discussed in Section 3.3.2.

Table C3.1 Summary of Source-Term Abstraction Approaches Based on Dose-Modeling Objective

	Screening	**Site-Specific**
OBJECTIVE: Identify DCGLs.	No source-term abstraction is necessary beyond radionuclide identification. (Assume unit radionuclide concentrations.)	Delineate proposed lateral and vertical extent of residual contamination. (Assume unit radionuclide concentrations.)
OBJECTIVE: Provide Dose Assessment.	Site-specific source-term abstraction incorporating spatial extent and variability	

3.3.1 Dose Modeling Objective One: Identify DCGLs

The MARSSIM approach, as documented in NUREG-1575 (NRC, 1997), requires that a licensee establish a set of DCGLs before conducting a final status survey. In fact, the design of the final status survey will be based on the identified DCGLs. DCGL is defined in MARSSIM as:

> “*...a derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion....DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.*”

The $DCGL_W$ is the concentration of a radionuclide which, if distributed uniformly across a survey unit, would result in an estimated dose equal to the applicable dose limit. The $DCGL_{EMC}$ is the concentration of a radionuclide which, if distributed uniformly across a smaller limited area within a survey unit, would result in an estimated dose equal to the applicable dose limit.

Two approaches are possible for developing DCGLs: screening and site-specific analysis.

Screening DCGLs The NRC has published radionuclide-specific screening DCGLs in the *Federal Register* for residual building-surface radioactivity and residual surface-soil radioactivity. The DCGLs in the *Federal Register* are $DCGL_W$s, in that they are intended to be concentrations which, if distributed uniformly across a building or soil surface, would individually result in a dose equal to the dose criterion. The licensee may adopt these screening DCGLs without additional dose modeling, if the site is suitable for screening analysis (see Section 2). Alternatively, the licensee may use the DandD computer code to develop screening DCGLs. The licensee would use the code to determine the dose attributable to a unit concentration of a radionuclide and scale the result to determine the DCGL for the radionuclide. Either of these methods for identifying screening DCGLs requires only that: (1) the licensee identify the radionuclides of concern for the site; and (2) the licensee demonstrate that the source term and model screening assumptions are satisfied. Thus, this approach requires essentially no source-term abstraction. The screening process and the source-term screening assumptions are discussed in detail in Section 2 of this document.

Before designing a final status survey, the licensee will likely need to identify a $DCGL_{EMC}$ for each radionuclide over a range of smaller limited areas. Since the conservative screening models of DandD are not appropriate for modeling small limited areas of contamination, use of the DandD screening code would likely result in $DCGL_{EMC}$ values that are overly conservative. Therefore, licensees will likely use other codes or approaches to develop $DCGL_{EMC}$ values. These would be considered “site-specific” analyses in that they would not be using the DandD code with the default screening values.

Site-Specific DCGLs The licensee may choose to identify site-specific DCGLs if: (1) the site conditions are not consistent with screening criteria; or (2) the licensee believes the screening DCGLs are unnecessarily restrictive. (Refer to Section 2 for a discussion of the screening criteria.) As defined in MARSSIM, the site-specific DCGLs will be derived from activity/dose relationships through various exposure pathway scenarios. “Site-specific” in this context may refer to the selection of conceptual models/computer models, physical (site) input parameter values, or behavioral/metabolic input parameter values. These aspects of site-specific analyses are discussed in other sections of this document. “Site-specific” may also refer to the source-term abstraction.

From the MARSSIM perspective, identifying a site-specific DCGL still begins with assuming a uniform radionuclide concentration across some source area (building surface) or volume (surface soil). The site-specific DCGL for a particular radionuclide will be identified by evaluating the dose resulting from a unit concentration and then scaling the result. Spatial variability of the radionuclide concentration within the area or volume is not evaluated in identifying the DCGLs, but is taken into account in the statistical analysis of the data collected during the final status survey. In identifying the site-specific DCGLs, the licensee may, however, take the spatial extent into account.

If the licensee is certain that the residual radionuclide concentration is limited to a specific lateral extent, the licensee may incorporate the “area of residual contamination” into the identification of DCGLs. This is similar to identifying a $DCGL_{EMC}$, and will generally result in an increased DCGL. If the licensee is using the DandD computer code to model doses, the licensee’s approach to this analysis may be similar to the approach for identifying the screening $DCGL_{EMC}$ discussed in the preceding section. Alternatively, other computer modeling codes, such as RESRAD, allow the user to directly specify the area of contamination. Through the final status survey, the licensee would have to demonstrate that the DCGL is satisfied within the specified area of residual contamination, and would have to demonstrate that residual contamination is not present outside the specified area of residual contamination. The licensee would still be required to develop $DCGL_{EMC}$s for smaller areas within the area of residual contamination, to adequately design the final status survey.

In addition to specifying a limited area of residual contamination in developing the site-specific DCGLs for soil, the licensee should also appropriately represent the vertical extent of residual contamination within the area. The screening DCGLs and the DandD code assume that residual contamination is contained within the uppermost 15 to 30 cm (6 to 12 in.) of soil. If the licensee intends to leave residual contamination at depths below 15 to 30 cm (6 to 12 in.), this should be reflected in the DCGL. Otherwise, leaving residual contamination below 15 to 30 cm (6 to 12 in.) may not be acceptable.

For subsurface contamination [i.e., contamination at depths greater than 15 to 30 cm (6 to 12 in.)], the reviewer should evaluate whether the licensee has reviewed existing historical site data (including previous processes or practices) and site characterization data to establish an adequate conceptual model of the subsurface source specifically regarding horizontal and vertical extent of contamination. Lateral and vertical trends of variation in concentration for each specific radionuclide should be evaluated. Since certain radionuclides have higher mobility than others, radionuclide ratios may not be maintained as constant across subsurface soil. In other words, radionuclide concentration within the unsaturated zone may vary depending on the original source location and the time since contamination existed. The reviewer should evaluate whether the licensee has reviewed the physical and chemical properties of the source and the surface/subsurface formation to assess potential for leaching or retardation within the natural physical system of the concerned site. In this context, the reviewer should evaluate the selected physical parameters and the physical conceptual model of the site versus actual subsurface geologic units or formation to ensure conservative selection of pertinent sensitive physical parameters. The reviewer should also consider physical variability in subsurface soil and the unsaturated zone, and the selected depth to water table considering the lower boundary of the subsurface source term.

If the thickness of residual contamination that the licensee intends to leave at the site is generally uniform across the site, the licensee may choose to use an upper bounding value for modeling the thickness. Alternatively, the licensee may choose to adopt an area-weighted approach to calculate an representative thickness. The representative thickness may be the area-weighted average value, or may reflect a conservative upper-percentile value. The reviewer should ensure that the representative thickness value proposed by the licensee does not significantly underestimate localized thicknesses at sites where the thickness of the proposed residually contaminated soil varies greatly across the site.

If appropriate, the licensee should provide maps and cross-sections detailing the proposed lateral and vertical extent of residual contamination left on the site.

3.3.2 Dose Modeling Objective Two: Assess Dose

An alternative objective that a licensee may have for performing and submitting dose modeling may be to assess doses attributable to specific quantities of radioactive material. Although the development of DCGLs focuses on the determination of radionuclide concentrations corresponding to a specified dose, the dose assessment objective focuses on the determination of doses corresponding to specified radionuclide concentrations.

In this situation, the licensee should give much more attention to the source-term abstraction. The licensee should address all elements of the source-term abstraction:

1. Identify the radionuclides of concern.
2. Delineate the spatial extent of residual contamination.
3. Represent the spatial variability of residual contamination.
4. Incorporate spatial variability of physical and chemical characteristics of the contaminated media.

The licensee should focus on the distribution of radioactive material expected to be present at the time of final status survey and subsequent site release. The licensee may assess doses attributable to existing radiological conditions at the site if the licensee can demonstrate that the existing radiological conditions reasonably bound conditions expected at final status survey, from a dose perspective.

The first two elements of source-term abstraction -- radionuclides of concern and spatial extent -- were considered in the discussion of source-term abstraction for development of DCGLs. Spatial variability was not considered since it is statistically evaluated after final status survey. In dose assessment, however, spatial variability must be factored into the source-term abstraction before dose modeling.

Assuming that the licensee has identified the radionuclides of concern and delineated the spatial extent of residual contamination, the licensee should provide a projection of residual radionuclide concentration distribution and total residual radionuclide inventory across the site. This projection should be directly tied to the characterization of existing radiological conditions at the site. The site may then be divided into relatively large areas that are radiologically distinct, based on radionuclide concentration or depth of residual contamination. The licensee should statistically demonstrate that the radionuclide concentrations or contamination depth within an area will be relatively uniform, taking into account the spatial distribution of the data. Similarly, within the larger areas, the licensee should statistically delineate relatively small areas of

projected elevated radionuclide concentrations or increased contamination depth. (The licensee should discuss reason for leaving the elevated concentrations in place as residual contamination.)

When complete, the licensee's source-term abstraction should define a site divided into relatively large areas of statistically uniform radionuclide concentrations and residual contamination depth. Within these areas may be relatively small areas of elevated concentration or increased depth. Assuming that the physical and chemical conditions across the site are relatively uniform, the licensee may use this source-term abstraction for modeling and proceed with the dose assessment. The following is a suggested approach:

1. Consider each relatively large area independently, and initially ignore the relatively small elevated areas within each large area.

2. Assess dose based on the properties of a large area, taking the areal extent into account.

3. Repeat the dose assessment, but assume essentially infinite areal extent. The specific approach will depend on the computer modeling code used. This will quantify the impact of dividing the site into artificial modeling areas.

4. Assess dose attributable to each limited area of elevated concentration, assuming no residual contamination exists outside the limited area. This may then be combined with the dose attributable to the surrounding larger area, to assess the impact of leaving the elevated concentrations.

The above discussion does not specifically address the determination of relatively significant large or small areas. This designation will depend on the areal assumptions underlying the computer modeling code used. For example, the DandD code considers the area of cultivation to be uniformly contaminated and irrigated. The area of cultivation depends on the cultivation requirements defined by the specific exposure scenario. Conversely, the RESRAD code considers a range of exposure-pathway specific areas [e.g., 400 m^2 (4300 ft^2) for soil ingestion; 1000 m^2 (11,000 ft^2) for plant ingestion; and 20,000 m^2 (5 ac) for milk and meat ingestion]. Therefore, the licensee should discuss and justify the designation of relatively large and relatively small areas, based on the computer code used. However, by providing the additional assessments identified above, where alternative areas are evaluated, the sensitivity of the dose modeling results to the area designation can be determined.

The licensee may also have to consider the impact of multiple areas of elevated concentration within a single larger area. In general, modeling two small areas independently and combining the results of the two dose assessments will result in a higher dose than if the two areas were combined and modeled as a single area. The higher dose is unrealistic in that it assumes that the receptor location relative to each contaminated area is such that dose is maximized from each contaminated area independently. For a more reasonable estimate of potential dose, these smaller areas may be combined into a single larger area if the concentrations within the smaller areas are comparable. If not, the licensee may model each smaller area individually, and conservatively combine the results.

4.0 CRITERIA FOR SELECTING AND MODIFYING SCENARIOS, PATHWAYS, AND CRITICAL GROUPS

4.1 Introduction

After the source term has been evaluated, the question becomes: "How could humans be exposed either directly or indirectly to residual radioactivity?" or "What is the appropriate exposure scenario?" Each exposure scenario must address the following questions:

1. How does the residual radioactivity move through the environment?
2. Where can humans be exposed to the environmental concentrations?
3. What are the exposure group's habits that will determine exposure? (e.g., what do they eat and where does it come from? How much? Where do they get water and how much? How much time do they spend on various activities? etc.)

The ultimate goal of dose modeling is to estimate the dose to a specific receptor. Broad generalizations of the direct or indirect interaction of the affected receptors with the residual radioactivity can be identified for ease of discussion between the licensee, regulator, public, and other interested parties. Scenarios are defined as reasonable sets of human activities related to the future use of the site. Therefore, scenarios provide a description of future land uses, human activities, and behavior of the natural system.

In most situations, there are numerous possible scenarios of how future human exposure groups could interact with residual radioactivity. The compliance criteria in Part 20 for decommissioning does not require an investigation of all (or many) possible scenarios; its focus is on the dose to members of the critical group. The critical group is defined (at 10 CFR 20.1003) as "...the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances."

By combining knowledge about the answers to (1) and (2), the licensee can develop exposure pathways. Exposure pathways are the routes that residual radioactivity travels, through the environment, from its source, until it interacts with a human. They can be fairly simple (e.g., surface-soil residual radioactivity emits gamma radiation, which results in direct exposure to the individual standing on the soil) or they can be fairly involved (e.g., the residual radioactivity in the surface soil leaches through the unsaturated soil layers into the underlying aquifer and the water from the aquifer is pumped out by the exposed individual for use as drinking water, which results in the exposed individual ingesting the environmental concentrations). Exposure pathways typically fall into three principal categories, identified by the manner in which the exposed individual interacts with the environmental concentrations resulting from the residual radioactivity: ingestion, inhalation, or external (i.e., direct) exposure pathways.

As required under Part 20, Subpart E, the dose from residual radioactivity is evaluated for the average member of the critical group, which is not necessarily the same as the maximally exposed individual. This is not a reduction in the level of protection provided to the public, but an attempt to emphasize the uncertainty and assumptions needed in calculating potential future doses, while limiting boundless speculation on possible future exposure scenarios. Although it is possible to actually identify with confidence the most exposed member of the public in some operational situations (through monitoring, time studies, distance from the facility, etc.), identification of the specific individual who will receive the highest dose some time (up to 1000 years) in the future is impractical, if not impossible. Speculation on his or her habits, characteristics, age, or metabolism could be endless. The use of the "average member of the critical group" acknowledges that any hypothetical "individual" used in the performance assessment is based, in some manner, on the statistical results from data sets (e.g., the breathing rate is based on the range of possible breathing rates) gathered from groups of individuals. Although bounding assumptions could be used to select values for each of the parameters (i.e., the maximum amount of meat, milk, vegetables, possible exposure time, etc.), the result could be an extremely conservative calculation of an unrealistic scenario and may lead to excessively low allowable residual radioactivity levels.

Calculating the dose to the critical group is intended to bound the individual dose to other possible exposure groups because the critical group is a relatively small group of individuals, because of their habits, actions, and characteristics, who could receive among the highest potential dose at some time in the future. By using the hypothetical critical group as the dose receptor, coupled with prudently conservative models, it is highly unlikely that any individual would actually receive doses in excess of that calculated for the average member of the critical group. The description of a critical group's habits, actions, and characteristics should be based on credible assumptions and the information or data ranges used to support the assumptions should be limited in scope to reduce the possibility of adding members of less exposed groups to the critical group.

4.2 Issues in Selecting and Modifying Scenarios, Pathways, and Critical Groups

The definition of scenarios, identification of a critical group with its associated exposure pathways, and the dose assessment based on that definition can be generic or site specific. Licensees might:

1. Use screening scenarios, screening groups, and pathway parameters as described in NUREG-1549 (NRC, 1998a) and NUREG/CR-5512, Volume 1 (Kennedy and Strenge, 1992). This can be used for either screening or site-specific analyses.
2. Use the default screening scenarios as a starting point to develop more site-specific pathway analyses or critical group habits.
3. Develop site-specific scenarios, critical groups, and identify associated exposure pathways from scratch.

To establish either site-specific scenarios, critical groups, and/or sets of exposure pathways, the licensee will need to provide justifications defending its selections. For some licensees, this may require minimum amounts of site-specific data to support the assumptions inherent in the existing default screening scenarios or for removing specific exposure pathways. For others, the licensee may need to thoroughly investigate and justify the appropriateness of the selected scenarios and/or critical groups, which may include evaluation of alternate scenarios and/or critical groups. If a licensee creates the exposure scenario and associated critical group based on site-specific conditions (e.g., at a site that is grossly different than the assumptions inherent in the default scenarios), the licensee should provide documentation that provides a transparent and traceable audit trail for each of the assumptions used in developing the exposure scenario and critical group [e.g., justify the inclusion (or exclusion) of a particular exposure pathway].

4.3 Recommended Approach

4.3.1 Screening Analyses

In the case of screening, the decisions involved in identifying the appropriate scenario and critical group, with their corresponding exposure pathways, have already been made. Scenario descriptions acceptable to the NRC for use in generic screening are developed and contained in NUREG/CR-5512, Volume 1. It, and NUREG-1549, provide the rationale for applicability of the generic scenarios, critical groups, and pathways at a site; the rationale and assumptions for scenarios and pathways included (and excluded); and the associated parameter values or ranges. A summary of the scenarios is in Table C4.1 and in Section 7. The latest version of the DandD computer code should contain the latest default data values for the critical group's habits and characteristics.

Table C4.1 Pathways for Generic Scenarios

Building Occupancy Scenario

This scenario accounts for exposure to fixed and removable residual radioactivity on the walls, floor, and ceiling of a decommissioned facility. It assumes that the building will be used for commercial or light industrial activities (e.g., an office building or warehouse).

Pathways include:
External exposure from building surfaces;
Inhalation of (re)suspended removable residual radioactivity; and
Inadvertent ingestion of removable residual radioactivity.

Resident Farmer Scenario

This scenario accounts for exposure involving residual radioactivity that is initially in the surficial soil. A farmer moves onto the site and grows some of his or her diet and uses water tapped from the aquifer under the site.

Pathways include:
External exposure from soil;
Inhalation to (re)suspended soil;
Ingestion of soil;
Ingestion of drinking water from aquifer;
Ingestion of plant products grown in contaminated soil and using aquifer to supply irrigation needs;
Ingestion of animal products grown onsite (using feed and water derived from potentially contaminated sources); and
Ingestion of fish from a pond filled with water from the aquifer.

4.3.2 Site-Specific Analyses[1]

Site-specific analyses can use the generic screening scenario(s) with a little justification. The licensee will need to justify that the site contains no physical features nor locations of residual radioactivity, other than those assumed in the screening analyses, that would invalidate the assumptions made in developing the scenarios. The reviewer should evaluate the justification to provide reasonable assurance that the default scenario would still be appropriate for the site. A site can fail to meet the requirements of the conceptual model (see Section 5.3.1) without invalidating the default scenario, and situations can arise where the default scenario is no longer the limiting case. For example, the site may have pre-

[1] In this section, unless specifically noted, the use of the word "scenario" includes the critical group definition and associated exposure pathways.

existing groundwater contamination, which is counter to the assumptions in the conceptual model inherent in the screening models (see Section 5.3.1), but this may not require any change in the exposure scenario because the residential farmer scenario will still be an appropriate scenario, as it contains all of the appropriate exposure pathways, including groundwater use for drinking, irrigation, and for animals. Alternately, if the residual radioactivity were a volumetric source in the walls of a building, rather than on the building surfaces, the default exposure scenario of an office worker may not be the scenario leading to the critical group. For certain sets of radionuclides, a building renovation scenario may be more limiting because of the exposure to airborne concentration of material as the walls are modified.

Site-specific scenarios, critical groups, and pathways can be developed and would occur in cases where, for example:

1. Major pathways (e.g., the groundwater pathway, or agricultural pathways) associated with the default screening scenarios could be eliminated, either because of physical reasons or site-use reasons;
2. The location of the residual radioactivity and the physical features of the site are outside the major assumptions defining the critical group and/or scenarios; and
3. Restricted use was proposed for a site.

The second situation listed above can be ambiguous, as a number of assumptions key to the development of the DandD screening tool do not affect the scenario description, and will require a reviewer to evaluate whether the initial default scenario would still be appropriate for the site.

Modifying scenarios or developing a site-specific critical group requires information regarding plausible uses of the site and demographic information. Such information might include considerations of the prevailing (and future) uses of the land, and physical characteristics of the site that may constrain site use. It may be necessary to evaluate several potential critical groups, based on different combinations of site-specific scenarios developed from expected pathways and demographics, to determine the group receiving the highest exposure.

For restricted release, similar considerations apply. When analyzing the dose under restricted conditions, the nature of the critical group is likely to change because of site restrictions and institutional controls, which can restrict certain kinds of activities and/or land or water uses, in combination with the physical features of the site. The detailed definition of the scenarios considered for restricted release need to include the impact of the control provisions on the location and behavior of the average member of the appropriate critical group. Restricted-release license-termination or decommissioning plans must also evaluate the impact if the restrictions were to fail. This may require the licensee to explore different “failure” exposure scenarios, including partial failure of engineered features of the site (e.g., engineered covers, subsurface engineered features whose partial failure may result in focused flow) and, more commonly, use of the site assuming a situation similar to unrestricted release.

The reviewer should evaluate the justifications provided by the licensee on its scenarios using the following appropriate guidance. The guidance is characterized by the general approach used in development of the scenarios: (1) modifying existing generic exposure scenarios; or (2) developing site-specific scenarios from “scratch.”

4.3.2.1 Modification of Generic Scenarios

First, the reviewer should evaluate whether the generic scenario was applicable to the site before modification (see Section 4.3.1 and the start of Section 4.3.2). If the scenario was applicable before the licensee started modifying the scenario based on physical features or restrictions, go to the next step and evaluate the justifications for the various modifications performed by the licensee. If the scenario was not initially applicable, that does not mean that a final modified scenario is inappropriate for the site conditions. It just means that the review may be more complex than a simple modification of a scenario and the reviewer should evaluate whether it may be more appropriate to evaluate the scenario using the guidance in Section 4.3.2.2.

The reviewer should identify the modifications done by the licensee to the scenario and evaluate the licensee's justification for those changes. Table C4.2 lists some common exposure scenarios, but is by no means comprehensive. The Sandia Letter Report, "Process for Developing Alternate Scenarios at NRC Sites Involved in D&D and License Termination" (Thomas, *et al.*, 2000) provides a series of flow charts and sources of information to assist a licensee or reviewer in modifying the default scenarios using site-specific information. See Section 4.3.3, below, for specific guidance on acceptable justifications using different types of site-specific information, which was adapted from Chapter 6 of the letter report. Additionally, if the licensee's intent is restricted release, the final scenario should be reviewed looking at the effect of site restrictions. The licensee's justifications should support, based on either site restrictions or site-specific data, the elimination of scenarios and/or pathways from the analysis. The reviewer should focus the review on the pathways, and models associated with those pathways, that have the highest likelihood of significant exposures to the critical group.

The licensee may need to evaluate whether the final modified scenario is still the limiting reasonable representation of the critical group at the site. This may involve investigation of exposure pathways not covered in the default scenarios.

Table C4.2 Potential Scenarios for use in Dose Assessments

General Scenario Classifications
Building occupancy (Generic screening - NUREG/CR-5512-based).
Residential farmer (Generic screening - NUREG/CR-5512-based).
Urban construction (contaminated soil, no suburban or agricultural uses).This scenario is meant for small urban sites cleared of all original buildings; only contaminated land and/or buried waste remains.
Residential (a more restricted subset of the residential farmer scenario, for those urban or suburban sites where farming is not a realistic projected future use of the site).
Recreational (where the site is preserved for recreational uses only).
Hybrid industrial building occupancy (adds contaminated soil, building may or may not be contaminated).
Drinking water (no on-site use of groundwater; off-site impacts from the contaminated plume).

4.3.2.2 Development of Alternate Scenarios

In some decommissioning cases, either the location of the residual radioactivity, the physical characteristics of the site, and/or planned institutional restrictions may make the default scenarios inappropriate. Development (and review) of alternate scenarios may involve iterative steps involving the development of the conceptual model of the site. For example, the licensee may: (1) develop a generic list of exposure pathways; (2) develop the site conceptual model to screen the generic list; (3) aggregate or reduce the remaining exposure pathways to the major exposure pathways, and (4) re-evaluate the conceptual model to verify that all the necessary processes are included.

A brief summary of the NRC-recommended pathway analysis process follows.

1. The licensee compiles a list of exposure pathways applicable to any contaminated site. There are a number of existing sources of information that can be used. One source is NUREG/CR-5512 (Kennedy and Strenge, 1992) and the list is summarized in Appendix C.1 of NUREG-1549 (NRC, 1998a). Another source, although the guidance is more focused on off-site exposures, is NUREG/CR-5453, Volumes 1 and 2, *Background Information for the Development of a Low-Level Waste Performance Assessment Methodology* (Shipers, 1989; Shipers and Harlan, 1989). Another potential source is the international “Features, Events and Processes,” list which is an expansive generic list that does not strictly deal with decommissioning issues (BIOMOVS II, 1996).

2. Categorize the general types of contamination at the site (e.g., sediment or soil, deposits in buildings, surface contamination, surface waters, groundwater, industrial products such as slag).

3. Screen out pathways, for each contaminant type, that do not apply to the site.

4. Identify the physical processes pertinent to the pathways for the site.

5. Separate the list of exposure pathways into unique pairs of exposure media (e.g., source to groundwater, groundwater to surface water, etc.). Determine the physical processes that are relevant for each exposure media pair and combine the processes with the pathway links.

6. Reassemble exposure pathways for each source type, using the exposure media pairs as building blocks, thus associating all the physical processes identified with the individual pairs with the complete pathway.

The licensee’s documentation of the decisions made regarding inclusion (or exclusion) of the various pathways should be transparent and traceable. An international working group of Biospheric Model Validation Study, Phase II (BIOMOVS II) established a methodology for developing models to analyze radionuclide behavior in the biosphere and associated radiological exposure pathways (i.e., the Reference Biospheres Methodology). BIOMOVS II published the methodology in its Technical Report No.6, “Development of a Reference Biospheres Methodology for Radioactive Waste Disposal” (BIOMOVS II, 1996), and it may be useful as a guide for additional information on a logical method to complete the pathway analysis sets above and include proper justification. Generally, the Reference Biospheres Methodology is more useful for complex sites that may have numerous physical processes that interact in such as a way that a number of different exposure groups may need to be investigated to discover the critical group. Additional work has been done on providing guidance by a working group of the International Atomic Energy Agency's Biosphere Modeling and Assessment (BIOMASS) program (BIOMASS, 1999). Specifically, IAEA Working Document BIOMASS/T1/WD03, *Guidance on the Definition of Critical and Other Hypothetical Exposed Groups for Solid Radioactive Waste Disposal* (BIOMASS, 1999a), may provide additional information on developing a site-specific critical group for situations where the default critical group is inappropriate.

4.3.3 Guidance on Specific Issues

4.3.3.1 Land Use

A licensee's justifications for changes in scenarios or exposure pathways based on local land use practices should focus on current practice in the region. The region of concern can be as large as an 80-kilometer (50-mile) radius. To narrow the focus of current land practices, the licensees can use information on how land use has been changing in the region, and more weight should be given to land-use practices either close to the site or in similar physical settings. This can be very important for semi-rural sites that are being encroached by suburban residential development. Reviewers may wish to involve State and local land-use planning agencies in discussions, if the licensee has not already requested their involvement.

Land use arguments by licensees often rely on State or local codes, in building or well development to constrain future use. In general, licensees looking for unrestricted release, should not rely solely on these arguments as reason, to remove pathways or change the scenario unless the radionuclides have a relatively short-half life (approximately 10 years or less), or the dose from long-lived radionuclides reaches its peak before 100 years.

4.3.3.2 Waterborne Exposure Pathways

Removal of waterborne exposure pathways can range from being global (e.g., all groundwater pathways) to being specific (e.g., no drinking water but still have agricultural/fish pond use). Acceptable justifications are generally based on physical conditions at the site rather than local codes (see Section 4.3.3.1). Justification of water quality and quantity of the saturated zone should be based on the classification systems used by the U.S. Environmental Protection Agency (EPA) or the State, as appropriate. Arguments involving depth to water table, or well production capacity, should have supporting documentation from either the U.S. Geological Survey (USGS), appropriate State agency, or an independent consultant.

Reviewers should evaluate the reasons for the classification. The Sandia Letter Report, "Process for Developing Alternate Scenarios at NRC Sites Involved in D&D and License Termination" (Thomas, *et al.*, 2000) provides a number of tables, in Chapter 6, detailing water quality standards. For example, where the aquifer is classified as not being a source of drinking water, but is adequate for stock watering and irrigation, the licensee can eliminate the drinking water pathway, but should still maintain the irrigation and meat/milk pathways. Aquifers may exceed certain constituents and still be able to be used for various purposes because those constituents may easily be treatable (e.g., turbidity). In cases where the water may be treatable or because the degree of connection between the aquifer and surface water may make the use of the aquifer questionable, the reviewer should involve the EPA and/or the State, as appropriate, in discussions on reasonable assumptions for the aquifer use.

4.3.3.3 Agricultural Pathways

Agricultural pathways may be removed or modified for various reasons: (1) land use patterns (see Section 4.3.3.1); (2) poor-quality soil; (3) topography; and (4) size of contaminated area (see Section 4.3.3.5). Many justifications will result in modification of the pathways, rather than complete elimination. For example, the soil may of inappropriate quality to support intensive farming activities, but residential gardening may still be reasonable.

Licensees using poor-quality soil as a justification for modifying the agricultural pathways should provide the reviewer with supporting documentation from the Soil Conservation Service, appropriate State or local agency, or an independent consultant. Reviewers should carefully consider whether the state of the soil would reasonably preclude all activities (e.g., because of high salinity of soil) or only certain activities. In most cases, soil quality can reasonably preclude activities such as intensive farming, but could allow grazing or small gardens.

When reviewing justifications involving topography, the reviewer should limit speculation of future topographical changes from civil engineering projects. The reviewer should evaluate the reasonableness of the critical group performing its activities on the current topography, for example, a slope. Supporting documentation should be provided by the licensee in the form of pictures, USGS or similar topographic maps, hand-drawn maps, or a detailed description of how the topography would limit farming. Reviewers may wish to perform a site visit to evaluate the topography firsthand.

4.3.3.4 Age-Dependent Critical Groups

When calculating for compliance with the requirements of Subpart E of Part 20, the intake-to-dose conversion factors used to calculate internal exposures, which are based primarily on adults, can be found in Federal Guidance Report No. 11 (EPA, 1988). As stated in EPA’s *Federal Register* notice (59 FR 66414, Dec. 23, 1994) on “Federal Radiation Protection Draft Guidance for Exposure of the General Public,” which proposes a public dose limit of 1 mSv (100 mrem) per year from all sources:

> These dose conversion factors are appropriate for application to any population adequately characterized by the set of values for physiological parameters developed by the [International Committee on Radiological Protection] and collectively known as “Reference Man.” The actual dose to a particular individual from a given intake is dependent upon age and sex, as well as other characteristics. As noted earlier, implementing limits for the general public expressed as age- and sex- dependent would be difficult...More importantly, the variability in dose due to these factors is comparable in magnitude to the uncertainty in our estimates of the risks which provide the basis for our choice of the [public dose limit]. For this reason EPA believes that, for the purpose of providing radiation protection under the conditions addressed by these recommendations, the assumptions exemplified by Reference Man adequately

> characterize the general public, and a detailed consideration of age and sex is not generally necessary. (59 *FR* 66423, Dec. 23, 1994)

Since age-based dose conversion factors are not being used, all individuals are assumed to have the same dose conversion factors. Because of this, only in very rare scenarios (generally, single-exposure pathway scenarios) will a non-adult individual intake more radionuclides, thereby resulting in a higher dose, than an adult in a similar exposure scenario. One example is the milk pathway - generally, children drink more milk annually than adults. If milk were the only pathway that would expose the individual to a dose, then the child could have a slightly higher dose than the adult. But in most situations, especially ones involving multiple pathways, the total intake of the adult is greater than that of a child. Therefore, the average member of the critical group should be assumed to be an adult and use the proper habits and characteristics of an adult.

4.3.3.5 Area Factors

The extent of residual radioactivity can be taken into account when modifying the default scenarios. The default scenarios assume large areas of homogeneous surface contamination. If the area of residual radioactivity is smaller than the defaults [e.g., 2400 m^2 (0.6 acres) for DandD], the licensee may propose modifying the exposure pathways to account for the effect on the critical group's activities. Two methods can be followed: (1) the licensee can reduce the calculated dose by the fraction of the default area or modify usage parameters accordingly; or (2) modify the exposure scenario and pathways to account for the size of the residual radioactivity. When the extent of residual radioactivity becomes smaller, some of the activities are no longer viable as reasonable assumptions for exposure. Generally, the first pathways affected are animal husbandry activities, because of the larger area needs for grazing and growing fodder. As a general rule, as the area gets smaller, the more the scenario transforms into a residential gardener scenario, so long as the initial residual radioactivity begins in the surface soil. For cases where the residual radioactivity is not in the surficial soil, the original area of contamination may not be as important in scenario development, because some of the primary transport mechanisms result in redistribution of the radionuclides over larger areas (i.e., groundwater used as irrigation).

4.4 Generic Examples

The following examples are provided as situations where the default pathways may be removed or modified.

4.4.1 Removal of Groundwater Pathways

A licensee has extensive contamination of the upper soil horizon and the upper aquifer, which is unconsolidated and the licensee wishes to remove the groundwater pathway because the upper aquifer would not be used as a water source. The aquifer shows relatively high levels of microbial activity, turbidity, and nitrates. In addition, adjacent to the site is a small patch of wetlands that shows a great deal of communication with the upper aquifer. The potential yield rate of the upper aquifer is sufficient for domestic use, but there is a better-quality, confined aquifer, whose horizon is at a depth of approximately 30 meters (98.4 feet). In this case, it is questionable where the upper aquifer would actually be used. Although it may be possible for someone to treat the contaminants and use the aquifer, there are better sources of water easily available. After consultation with the EPA and the State, it is agreed that it would be unreasonable to assume someone would use the upper aquifer as a water source. Therefore, the licensee is allowed to remove the groundwater pathway from the scenario.

4.4.2 Scenario Development for Buried Residual Radioactivity

A site has residual radioactivity buried at a few feet below the surface and the licensee is requesting unrestricted release. The residual radioactivity does not have enough highly energetic gamma-emitters to result in an external dose in the current configuration. Two exposure scenarios can be developed (without any other site-specific information): (1) leaching of the radionuclides to the groundwater, which is then used by a residential farmer; and (2) inadvertent intrusion into the buried residual radioactivity by house construction for a resident farmer with the displaced soil, which includes part of the residual radioactivity, spread across the surface. Exposure Scenario 2 encompasses all the exposure pathways and, although not all of the source term is in the original position, leaching will occur both from the remaining buried residual radioactivity and the surface soil. Except for cases where an additional 0.6 m (2 ft) of unsaturated zone will make a tremendous difference in travel time to the aquifer, the groundwater concentrations should be similar and, therefore, analysis of exposure scenario 2 appears to be the appropriate scenario for the critical group exposure.

At another site, the licensee is requesting unrestricted release of its site. It is removing the buildings, but is evaluating the need to remove the concrete pads, which have imbedded piping that contains the residual radioactivity. Two scenarios can be reasonably envisioned. The first scenario involves a resident farmer onsite. The farmer builds a house on the concrete pad, without disturbing the imbedded piping. Possible exposure pathways would be external dose from the piping and exposure to leached materials from the piping through groundwater use (e.g., drinking, irrigation, etc.). The second is similar to the building renovation scenario, where the concrete pad and piping are removed from the site. The licensee should investigate both to find the limiting scenario.

4.4.3 Scenario Development for Restricted Release

The site restrictions planned for an alternate site include a restriction, for this example, on the deed, on the use of the property for only parkland, and an engineered cover is placed over the residual radioactivity. The engineered cover is contoured for use as parkland, with a vegetative cover (i.e, not a mound covered in rip-rap). Two scenarios are easily envisioned for the restricted release analysis. The first is recreational use of the property as a city park or golf course, with exposure scenarios being limited to possible external exposure. The second would involve off-site use of groundwater that contains radionuclides leached from the buried residual radioactivity. The off-site user would be, as a default, a resident farmer using the groundwater for all of his/her water needs.

The unrestricted case would involve the removal of the institutional control (i.e., the deed restriction) and failure of the engineered cover. Again, two main scenarios can be envisioned.

The first scenario is similar to the default exposure and would involve a residential farmer that uses groundwater from the aquifer under the site. The engineered cover will have been compromised by the placement of the buildings but the cover may still work in some degraded function (e.g., the water infiltration rate would increase from the design rate to some higher rate, but probably not as high as the infiltration rate would have been if the cover had never been constructed). Whether buried residual radioactivity had been transported to the surface by construction of the basement of the resident farmer’s house would depend on the thickness of the engineered cover. If typical basement depth were deeper than the engineered cover’s thickness, some portion of residual radioactivity would be transported to the surface, mixed with the “clean” cover material, and spread over the site.

The second scenario would involve possible erosion of the cover and subsequent exposure of an on-site resident to the buried radionuclides or radionuclides redistributed by surface water. The exposure scenario would still be a resident farmer. The reasonableness of this scenario would depend on the thickness and erosion-resistence of the engineered cover.

5.0 CRITERIA TO ESTABLISH CONCEPTUAL MODELS

5.1 Introduction

Analyzing the release and migration of radionuclides through the natural environment and/or engineered systems, at a specific site, requires the licensee to interpret the nature and features of the site so that the site can be represented by mathematical equations (i.e., mathematical models). This simplified representation of the site, including the associated mathematical models, is commonly referred to as the conceptual model of the site.

Figure C5.1 depicts the process of conceptual model development. In dose assessments, developing a conceptual model involves making an abstraction of site data into a form that is capable of being modeled. This development will generally involve making simplifying assumptions, including simplification of the appropriate governing equations, to reflect the physical setting. These simplifying assumptions are usually made in describing the geometry of the system, spatial and temporal variability of parameters, isotropy of the system, and the influence of the surrounding. The conceptual model should provide an illustration, or description, of site conditions, which shows, or explains, contaminant distributions, release mechanisms, exposure pathways and migration routes, and potential receptors. In other words, the conceptual model should explain or illustrate how radionuclides enter, move through, and/or are retained in, and leave, the environment.

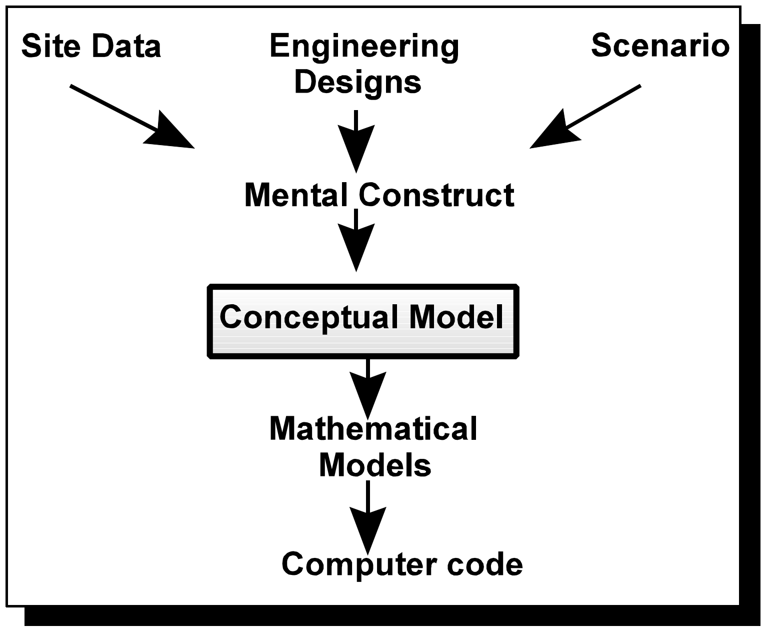

Figure C5.1 Conceptual model development.

As shown in Figure C5.2, developing a conceptual model at a site is Step 3 of the Decommissioning Decision Framework documented in NUREG-1549. Conceptual model development follows after assimilation of site data (Step 1) and definition of scenarios (Step 2), because information from these two steps feeds into its development. In other words, the conceptual model should be based on what is known about the site from data and information gathered as part of Step 1, and how the site evolves during the period covered by the analysis based on the assumed land-use scenario defined under Step 2.

Mathematical models are a quantitative representation of the conceptual model. Because the conceptual model provides the linkage between site conditions and features (Steps 1 and 2) and the computer code(s) (with its associated mathematical models) used in the dose analysis

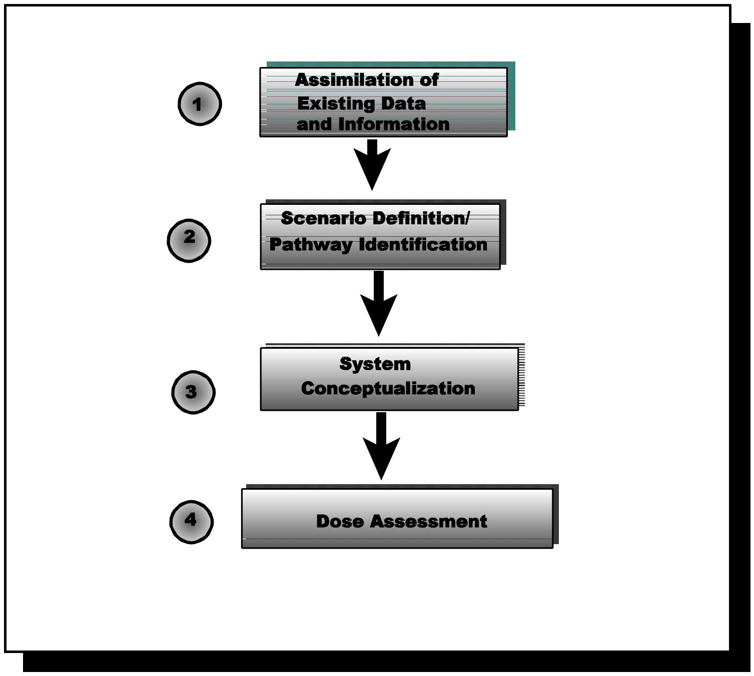

Figure C5.2 Decommissioning Decision Framework.

(Step 4 of the Decommissioning Framework), it is a key step in a dose assessment and should not be taken lightly.

5.2 Issues

Uncertainties in conceptual models can be large, and possibly even larger than uncertainties in parameters used in the analysis (James and Oldenburg, 1997). Thus, conceptual model uncertainties can be a significant source of uncertainty in the overall dose assessment. Uncertainties in the conceptual model(s) are generally caused by incomplete knowledge about the natural system being analyzed and differing views about how to interpret data representing the system.

Development of conceptual models is a subjective process based on interpretation of limited (or in most cases, sparse) site data. From these limited data, we must determine the key processes and features at the site and how they are likely to affect the movement of radionuclides through the environment. Because our construct of the site is based on incomplete information, it is possible that multiple interpretations of the same data can be derived. A licensee must also determine the appropriate level of simplification acceptable for representing the site. An overly simplified conceptual model may leave out key site features or conditions that are important in estimating where radionuclides are likely to be transported (thus, where people might be exposed) and when they might get there (thus, the radionuclide concentration when it arrives). On the other hand, an overly complex conceptual model may introduce unnecessary uncertainty and costs into the analyses. As a broad example, simple models contained in screening codes may oversimplify features and processes at a specific site. The licensee also needs to ensure that the appropriate level of detail is provided in the conceptual model. It is important that the conceptual model have sufficient detail and scope for a license reviewer to be able to assess the appropriateness of the computer codes used in the analysis and the defensibility of the assumptions made. In summary, key issues in developing and presenting the conceptual model are: (1) identifying the important site features and processes that need to be included in the conceptual model; (2) deciding among possible competing interpretations of the site data; and (3) and determining the level of detail needed to describe those features and processes.

5.3 Recommended Approach

5.3.1 Screening

An acceptable dose assessment analysis need not incorporate all the physical, chemical, and biological processes at the site. The scope of the analysis, and accordingly the level of sophistication needed in the conceptual model, should be based on the overall objective of the analysis. A performance assessment conceptual model can be simple if it still provides satisfactory confidence in site performance. For an initial screening analysis, little may be known about the site from which to develop a conceptual model. Computer codes used for screening analyses are generally intended to provide a generic and conservative representation of processes and conditions expected for a wide array of sites. Accordingly, the generic conceptual model in such codes may not provide a close representation of conditions and processes at a specific site. Such a generic representation is still acceptable as long as it provides a conservative assessment of the performance of the site.

The DandD code has two default land-use scenarios; a building occupancy and a resident farmer scenario. The building occupancy scenario is intended to account for exposure to both fixed and removable residual radioactive contamination within a building. Exposure pathways included in the building occupancy scenario include external exposure to penetrating radiation, inhalation of resuspended surface contamination, and inadvertent ingestion of surface contamination. The resident farmer scenario is intended to account for exposure to residual radioactive contamination in soil. Exposure pathways included in the resident farmer scenario include: external exposure to penetrating radiation; inhalation exposure to resuspended soil; ingestion of soil; and ingestion of contaminated drinking water, plant products, animal products, and fish. The predefined conceptual models within DandD are geared at assessing releases of radioactivity, transport to, and exposure along, these pathways.

For the building occupancy scenario, DandD models external exposure to penetrating radiation as an infinite area source, using surface source dose rate factors from Federal Guidance Report No. 12 (EPA, 1993). Exposure to inhalation of resuspended surface contamination is modeled as a linear static relationship between surface contamination and airborne concentrations. The model accounts for ingrowth and decay. Exposure to incidental ingestion of surface contamination is modeled with a constant transfer rate.

The generic conceptual models for the resident farmer scenario are more complicated because of the large number of exposure pathways and considerations of release of radioactivity from the source area and transport of radionuclides in the environment. DandD models external exposure from volume soil sources when the person is outside as an infinite slab of contamination 15 cm (6 in.) thick, using dose rate factors from Federal Guidance Report No.

12, for volume contamination. When the person is indoors, exposure from external radiation is modeled in a similar manner, except the exposure is assumed to be attenuated through the use of a shielding factor (note: the higher the shielding factor, the lower the assumed attenuation). Exposure through ingestion of contaminated animal and plant products is modeled simply through the use of transfer factors. Instantaneous equilibrium is assumed to occur between radionuclide concentration in the soil and the concentration in plants, and between animal feed and animal products.

The generic source-term conceptual model in DandD assumes a constant release rate of radionuclides into the water and air pathways. Release of radionuclides by water is assumed to be downward and a function of a constant infiltration rate, constant contaminant zone thickness, constant moisture content, and equilibrium adsorption. DandD assumes that there are no radioactive gas or vapor releases. Release of radioactive particulates is assumed to be upward, instantaneous, uniform, and a function of a constant particulate concentration in the air and the radioactivity within the soil. Radionuclides in the contaminant zone are assumed to be uniformly distributed in a single soil layer, 15 cm (6 in.) thick. No transport is assumed to occur within the source zone, but radioactive decay is taken into account. In terms of containment, DandD assumes that there are no containers (or that they have failed), and that there is no cover over the contaminated zone.

The DandD generic conceptual model for the groundwater pathway assumes a single hydrostratigraphic layer for each of the unsaturated and saturated zones. The unsaturated zone (vadose zone) can be broken into multiple layers within DandD; however, each layer is assumed to have the same properties. For radionuclides entering the vadose zone, DandD accounts for adsorption-limited leaching by considering the vadose zone to behave as a well-mixed chemical reactor with a constant water inlet and outlet rate set at the infiltration rate. Accordingly, it is assumed that the vertical saturated hydraulic conductivity of the unsaturated zone is greater than or equal to the infiltration rate (i.e., there is no ponding or runoff on the surface). The outlet concentration from one unsaturated zone layer to another is assumed to be a function of the constant infiltration rate, equilibrium partitioning, the thickness of the layer, a constant moisture content, and radioactive decay. Radionuclides entering the saturated zone are assumed to be instantaneously and uniformly distributed over a constant volume of water equivalent to the larger of either the volume of infiltrating water (i.e., the infiltration rate times the contaminated area) or the sum of the water assumed to be removed for domestic use and irrigation. Based on the default parameters in DandD Version 1.0, dilution in the groundwater pathway is based on the water use. The volume of water that radionuclides is assumed to be diluted in is roughly equivalent to 1250 m^3 (44,100 ft^3). No retardation is assumed to occur in the aquifer; however, radioactive decay is taken into account. A volume of contaminated water equivalent to the irrigation volume is assumed to be returned annually to the source zone. The concentration of radionuclides in the irrigation water is assumed to remain constant during the year. Radionuclides deposited on the vegetation are assumed to be removed at a constant rate. The DandD groundwater model should generally provide a conservative representation of the groundwater system because it allows very little dilution and nominal attenuation.

The generic surface-water conceptual model in DandD assumes that radionuclides are uniformly mixed within a finite volume of water representing a pond. The default pond volume in DandD Version 1.0 is 1300 m^3 (46,000 ft^3). Radionuclides are assumed to enter the pond at the same time and concentration as they enter the groundwater. Accordingly, there is assumed

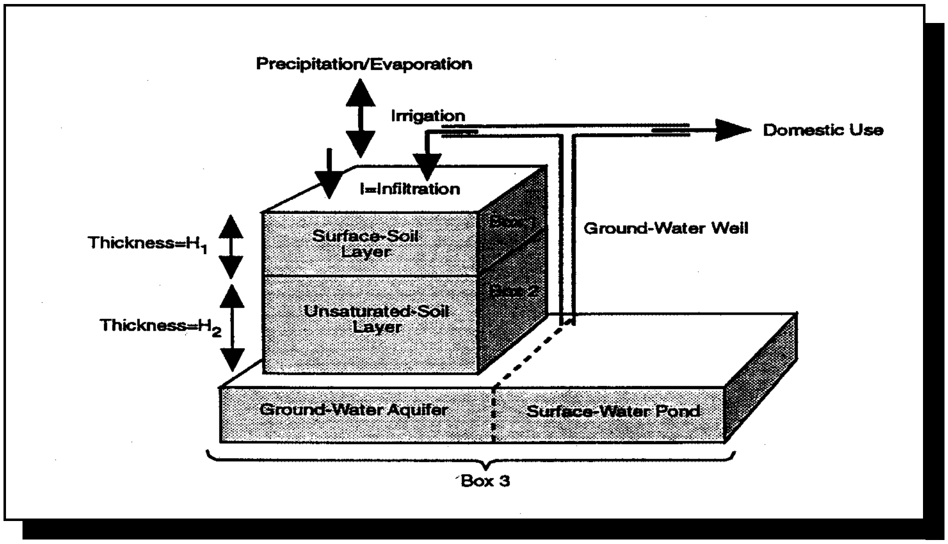

Figure C5.3 DandD conceptual model of the groundwater and surface-water systems (from Cole, *et al.*, 1998).

to be no transport of radionuclides through the groundwater to the pond and thus no additional attenuation (besides the initial groundwater dilution) is assumed for transport in the groundwater. The surface-water model within DandD should provide a conservative dose estimate as long as a small volume is assumed for the surface-water pond. Because the parameters in DandD are selected to provide a conservative dose estimate, the generic conceptualization of the surface-water pathway should generally provide a conservative representation of transport of radionuclides through the surface-water pathway. Figure C5.3 shows the generic groundwater and surface-water conceptual model within DandD.

The generic conceptual model of the air pathway in DandD assumes an equilibrium distribution between radionuclides in the air and soil. The concentration in air is assumed to be a function of the soil concentration and a constant dust loading in the air. Accordingly, all radionuclides in the air are assumed to be in a particulate form. The air pathway model within DandD is very simple and should generally allow a conservative dose estimate as long as a conservative particulate concentration is assumed. For DandD Version 1.0, a default particulate concentration of $4x10^{-4}$ g/m^3 ($2.5x10^{-8}$ lb/ft^3) is assumed for the garden area, and $3.1x10^{-6}$ g/m^3 ($2.0x10^{-10}$ lb/ft^3) for the rest of the outdoors. Because the default parameters in DandD are geared to be conservative, in general the air pathway in DandD should allow a conservative dose estimate.

In general, the conceptual models within DandD are expected to provide a conservative representation of site features and conditions. Therefore, for screening analyses, NRC will consider such generic conceptual models to be acceptable provided it is acceptable to assume that the initial radioactivity is contained in the top layer (building surface or soil) and the remainder of the unsaturated zone and groundwater are initially free of contamination. In using DandD for site-specific analyses, it is important to ensure that a more realistic representation of the site that is consistent with what is known about the site would not lead to higher doses. Some site features and conditions that may be incompatible with the generic conceptual models within DandD are listed in Table C5.1.

For any site where it is known that one or more of these conditions or features are present, the licensee should provide an appropriate rationale on why the use of the DandD will not result in an underestimation of potential doses at the specific site.

Table C5.1 Site Features and Conditions That May Be Incompatible with Those Assumed in DandD

Sites with highly heterogeneous radioactivity; Sites with wastes other than soils (e.g., slags and equipment); Sites that have multiple source areas; Sites that have radionuclides that may generate gases (e.g., ^{3}H and ^{14}C); Sites that have contaminated zones thicker than 15 cm (6 in.); Sites with chemicals or a chemical environment that could facilitate radionuclide releases (e.g., colloids); Sites with soils that have preferential flow conditions that could lead to enhanced infiltration; Sites with a perched water table, surface ponding, or no unsaturated zone; Sites where the groundwater discharges to springs or surface seeps; Sites with existing groundwater contamination; Sites where the potential groundwater use is not expected to be located immediately below the contaminated zone; Sites with significant transient flow conditions; Sites with significant heterogeneity in subsurface properties; Sites with fractured or karst formations; Sites where the groundwater dilution would be less than 2000 m^3 (70,000 ft^3); Sites where overland transport of contaminants is of potential concern; Sites with radionuclides that may generate gases; and Sites with stacks or other features that could transport radionuclides off the site at a higher concentration than onsite.

As example, it may be possible to demonstrate the acceptable use of DandD for analyzing sites that contain ^{3}H and ^{14}C, although both radionuclides may be occur as a gas. The following approach can be used to demonstrate the acceptable use of DandD for analyzing sites that contain either ^{3}H or ^{14}C (Haaker, 1999): (1) determine the area of the contaminated zone; (2) run DandD for the site with only ^{3}H or ^{14}C; (3) read the associated activity ratio factor for the given area from Figure C5.4; and (4) estimate the potential missed dose by multiplying the inhalation dose calculated from DandD by the activity ratio factor.

5.3.2 Site-specific

For site-specific analyses, the intent is to provide a more realistic assessment of doses based on more site-specific information and/or data. Presumably for such analyses, more is known about the site from which to develop a conceptual model. For site-specific analyses, the licensee should provide a schematic or verbal description of the problem that it is attempting to analyze. Even when using a computer code that has a predefined conceptual model, it is important for the licensee to identify any site features or conditions that may differ from those assumed in the code. In developing a site-specific conceptual model or identifying potential limitations with a predefined conceptual model, the issues listed in Table C5.2 should be considered.

Table C5.2 Issues To Be Considered in Developing a Site-Specific Conceptual Model

Whether a more realistic representation of the site would lead to higher doses; Whether the conceptual model accounts for the most important physical, chemical, and biological processes at the site; Whether the conceptual model adequately represents responses to changes in stresses; and Whether the conceptual model includes consistent and defensible assumptions.

Because conceptual models are developed based on limited data, in most cases more than one possible interpretation of the site can be justified based on the existing data. This uncertainty should be addressed by developing multiple alternative conceptual models and proceeding forward with the conceptual model(s) that provides the most conservative estimate of the dose and yet is consistent with the available data. Consideration of unrealistic and highly speculative conceptual models should be avoided. Consistent with the overall dose modeling framework of starting with simple analyses and progressing to more complex modeling, as warranted, it may be advisable for the analyst to begin with a simple, conservative analysis that incorporates the key site features and processes and progress to more complexity only as merited by site data. It is important to stress that a simple representation, of the site, in itself does not mean that the analysis is conservative. It is incumbent on the licensee to demonstrate that its simplification is justified, based on what is known about the site and the likelihood that alternative representations of the site would not lead to higher calculated doses.

In general, there are two primary areas of the dose analysis where the conceptual model is expected to change from one site to another; these are related to the source term and environmental transport. Aspects of the analysis related to the exposure pathways in the

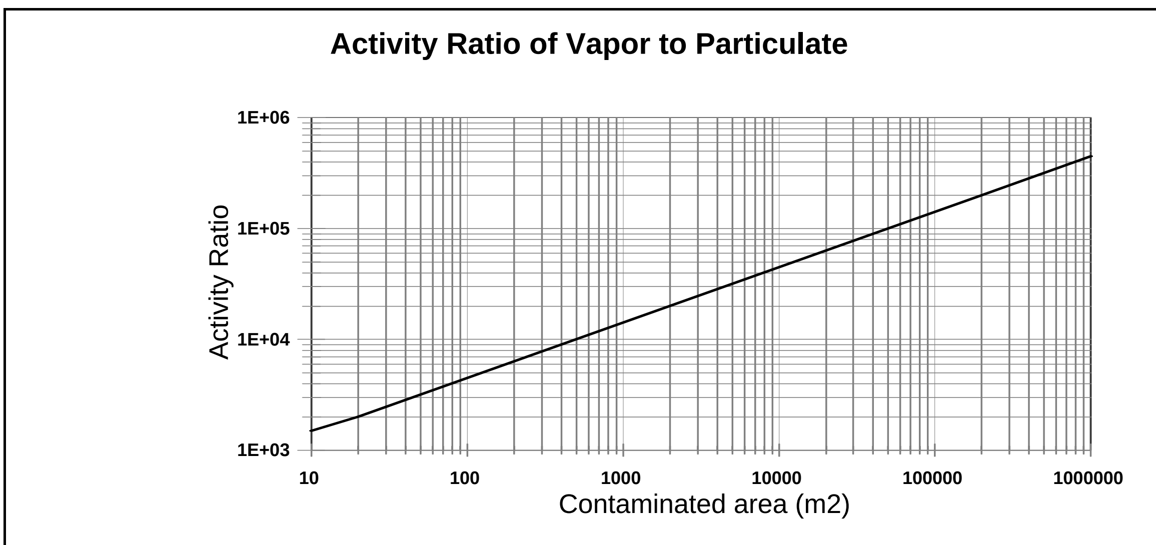

Figure C5.4 Activity ratio of vapor to particulate as a function of contaminated area.

biosphere and dosimetry are largely determined by the scenario and the assumed behavior of the critical group. Accordingly, models related to the exposure pathways in the biosphere and dosimetry should not change from one site to another unless there is a significant change in the scenario and associated critical group. The principal environmental transport pathways that will have to be considered in a dose assessment are groundwater (including transport through the unsaturated zone), surface water, and air.

The conceptual model of the source area should describe the contaminants and how they are likely to be released into the environment. Specifically, it should describe key features and processes such as the infiltration of water into the source area, the geometry of the source zone, the distribution of contaminants, release mechanisms, the physical form of the contaminants, near-field transport processes, and containment failure. If the contaminants are assumed to be uniformly distributed, this is an important assumption that needs to be justified because in general contaminants will not be uniformly distributed (see discussion under "Criteria for Source-Term Abstraction"). The source description should clearly identify how the contaminants are assumed to be released from the media. Common release mechanisms are diffusion, dissolution, surface release, and gas generation. The source description should also identify key processes and features that may retain or limit the release of contaminants from the source area (e.g., solubility and sorption). In addition, the description of near-field transport should state assumptions made regarding the dimensionality. In general, the assumption of one-dimensional vertical flow should be appropriate, unless there is some type of barrier present that may hinder flow in the vertical direction. The description of the source term should also describe failure mechanisms for any containment (e.g., corrosion, concrete degradation, or cover degradation) if containers or other forms of containment are present.

The conceptual model of the groundwater pathway should describe how contaminants could migrate through the unsaturated and saturated zones to potential receptors (e.g., a well, spring, or surface-water bodies). Essential features that should be included in the conceptual model include hydrostratigraphic units; information on the geometry of the pathway (i.e., boundaries and boundary conditions); the physical form of the contaminants (i.e., dissolved, suspended sediment, gas, etc.); structural features of the geology (i.e., those that influence contaminant transport such as fractures, faults, and intrusions); and physical and chemical properties. Important processes that should be characterized include the dimensions and state conditions (e.g., steady-state) of flow; dimensions and state conditions of transport (e.g., dispersion); chemical and mass transfer processes (e.g., sorption, precipitation, complexation); and transformation processes (e.g., radioactive ingrowth and decay). Although contaminant migration through both the unsaturated and saturated zones is best represented in three dimensions, it may be appropriate to assume only one or two dimensions, if this provides a more conservative representation of contaminant migration, and/or if it can be demonstrated that migration in one or more other directions is not expected to result in exposure to potential receptors.

The conceptual model of the surface-water pathway should describe potential contaminant migration through surface-water bodies such as lakes, streams, channels, or ponds to potential receptors. Essential features that should be included in the conceptual model include: the geometry of the surface-water body (i.e., boundaries and boundary conditions); the physical form of the contaminants (e.g., dissolved or solid); and physical and chemical properties. Key processes that should be described include: the dimensions and state conditions of flow and transport; chemical and mass transfer processes (e.g., sorption, precipitation, volatization); and transformation. One key boundary condition that should be described is how the contaminants are expected to initially mix or interact with the surface water.

The conceptual model of the air pathway should describe potential contaminant migration through the air to potential receptors. Essential features that should be included in the conceptual model are similar to those for the other environmental pathways -- namely, the geometry (i.e., boundaries and boundary conditions); form of contaminants (e.g., particulates or gases); and physical and chemical properties. Key processes that should be described include the dimensions and state conditions of flow and transport, and transformation processes.

5.3.2.1 Site-Specific Computer Codes

Two common computer codes used for site-specific analyses are RESRAD and RESRAD-BUILD. Both these computer codes have predefined conceptual models. Therefore, in using these codes, it is important for the licensee to demonstrate that key site features and conditions are consistent with the modeling assumptions within the codes or, where they are not consistent, the analysis will not result in an underestimation of potential doses.

5.3.2.1.1 RESRAD-BUILD

The RESRAD-BUILD code can be used to evaluate doses for the building occupancy scenario. It considers exposure from external radiation at the source and air submersion, inhalation of airborne material, and inadvertent ingestion of radioactive material. Exposure to direct radiation at the source is calculated using surface source dose rate factors from Federal Guidance Report No. 12. RESRAD-BUILD incorporates correction factors to account for a finite area source, for any offset of the receptor from the axis of the disk of contamination, and for shielding by material covering the contamination. Exposure to external radiation from air submersion is calculated as an infinite cloud of material using dose rate conversion factors for an infinite cloud. RESRAD-BUILD models airborne concentration of radionuclides using a dynamic model that accounts for the kinetic introduction and removal of radioactive material to and from indoor air. Exposure to incidental ingestion of radioactive material is modeled using a constant transfer rate.

5.3.2.1.2 RESRAD

RESRAD can be used for analyzing the resident farmer scenario. As with the generic conceptual models used by DandD for analyzing the resident farmer scenario, the conceptual models in RESRAD (see Figure C5.5) are more complex than those in RESRAD-BUILD. RESRAD models external exposure from volume soil sources when the person is outside, using volume dose rate factors from Federal Guidance Report No. 12. Correction factors are used to account for soil density, areal extent of contamination, thickness of contamination, and cover attenuation. When the person is indoors, exposure from external radiation is modeled in a similar manner except that additional attenuation is included to account for the building. Exposure through ingestion of contaminated animal and plant products is modeled simply through the use of transfer factors.

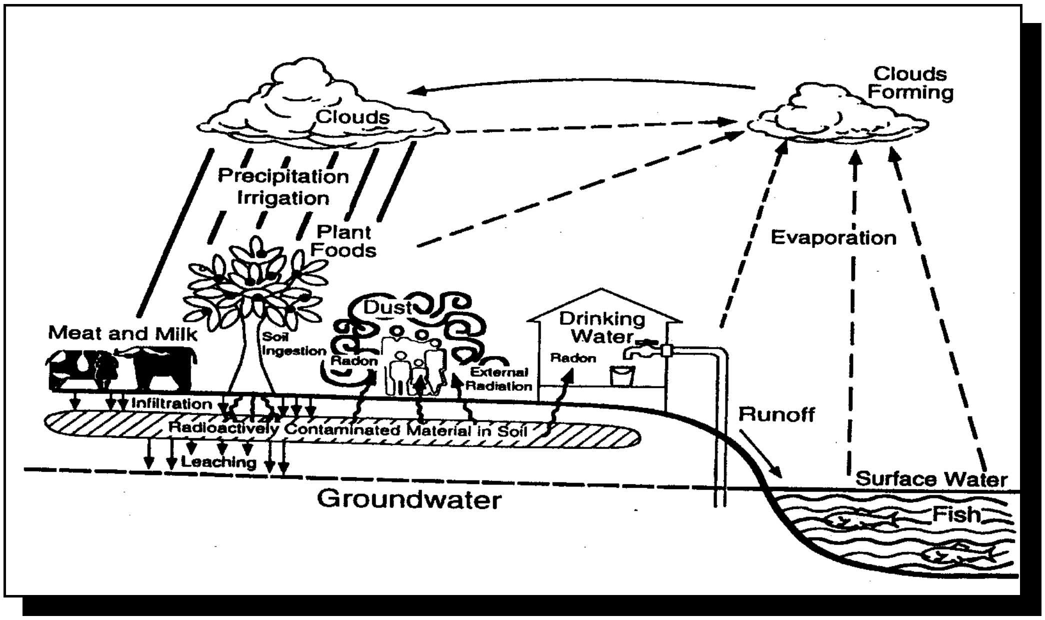

Figure C5.5 Conceptualization modeled by RESRAD (from Yu, *et al.*, 1993).

The generic source-term conceptual model in RESRAD assumes a time-varying release rate of radionuclides into the water and air pathways. Radionuclides in the contaminant zone are assumed to be uniformly distributed. No transport is assumed to occur within the source zone, but radioactive decay is accounted for. In terms of containment, the radioactive material is not assumed to be contained (or containers are assumed to have failed). RESRAD does allow inclusion of a cover over the contaminated area. However, the cover is not assumed to limit infiltration of water, and is assumed to function only in terms of providing shielding from gamma radiation. Release of radionuclides by water is assumed to be a function of a constant infiltration rate, time-varying contaminant zone thickness, constant moisture content, and equilibrium adsorption. The contaminant zone is assumed to decrease over time from a constant erosion rate. RESRAD assumes a uniform release of tritium and ^{14}C gases, based on a constant evasion loss rate. Particulates are assumed to be instantaneously and uniformly released into the air as a function of the concentration of particulates in the air, based on a constant mass loading rate.

The RESRAD generic conceptual groundwater model assumes one or more horizontal homogeneous strata for the unsaturated zone. Transport in the unsaturated zone is assumed to result from steady-state, constant vertical flow, with equilibrium adsorption, and decay, but no dispersion. RESRAD has two different ways of modeling radionuclides once they reach the saturated zone. In the mass-balance approach, radionuclides entering the saturated zone are assumed to be instantaneously and uniformly distributed over a constant volume equivalent to the volume of water removed by the hypothetical well (as long as the pumping rate is larger than the rate of leachate entering the groundwater -- if not, no dilution is assumed to occur in the groundwater). For the mass-balance approach, radionuclides are assumed to enter a well pumping immediately beneath the contamination zone. The mass-balance approach is very similar to the groundwater modeling approach in DandD. In the nondispersion approach, transport in the saturated zone is assumed to occur in a single homogeneous stratum, under steady-state, unidirectional flow, with a constant velocity, equilibrium adsorption, and decay. It assumes no dispersion; however, radionuclides are assumed to be diluted by clean water as a function of the assumed capture zone of the hypothetical well, in relation to the width of contamination and the depth of contamination, in relation to the depth of the hypothetical well. Radioactive decay and equilibrium adsorption are assumed to occur for the nondispersion approach. Further, radionuclides are assumed to enter a well located at the immediate downgradient edge of the contamination zone. For the nondispersion model, the calculated width of the effective pumping zone could be a factor of 2 larger than what one would predict from a steady-state capture zone analysis; this could lead to a slight overestimation in the amount of dilution (Haaker, *et al.*, 1999).

In determining which of these two conceptual models to use, consideration must be given to where the hypothetical well will be located (i.e., either at the center of the contamination or at the edge of the contamination); the relative half-life of the radioactivity; and the potential capture zone of the hypothetical well. Use of the nondispersion model will generally result in lower estimated doses. Both models assume that radionuclides enter the well as soon as they reach the water table. However, the nondispersion model, unlike the mass-balance model, calculates the time it takes for the peak concentration to occur after the initial breakthrough. Accordingly, the nondispersion model accounts for radioactive decay during the interval between the initial breakthrough and arrival of the peak concentration. Generally, the amount of decay should be small unless the radionuclides have short half-lives and are retarded. In addition, unlike with the mass-balance model, for the nondispersion model no assumption is made that all radionuclides released from the contaminated zone are withdrawn through the well. Therefore, the nondispersion model will generally include dilution. The only way that dilution is not considered is if the expected capture zone of the hypothetical well is small in relation to the width and thickness of the contamination. Because the nondispersion model will generally give a lower estimated dose than the mass-balance model, it is important for the licensee to justify the use of this model for the specific analysis. Use of the mass-balance approach should always be acceptable. Use of the nondispersion model should be acceptable, without additional justification, for modeling long-lived radionuclides (i.e., where radioactive decay is not important) when either of the following conditions are met:

$$\frac{U_w}{\bar{\bar{v}} \bullet d_w} > \frac{A}{len} \quad and$$

$$\left(\frac{I}{\bar{\bar{v}}}\right) len < d_w \qquad \text{Eq. C5.1}$$

or

$$\frac{U_W}{\bar{v} \bullet d_W} \leq \frac{A}{len} \quad and$$

$$\left(\frac{I}{\bar{v}}\right) len \geq d_W \qquad \text{Eq. C5.2}$$

Where:

U_w ≡ pumpage rate from the well (m^3/y);
v ≡ groundwater darcy velocity (m/y);
A ≡ area of contamination (m^2);
d_w ≡ depth of well intake below water table (m);
len ≡ length of contamination parallel to groundwater flow (m); and
I ≡ infiltration rate (m/y).

As a general rule, use of the nondispersion approach should be acceptable when the area of contamination is known to be larger than the assumed capture area of the hypothetical well. Assuming an essentially flat water table and steady-state conditions, the capture area of the hypothetical well can be calculated as follows:

$$A_W = \left(\frac{U_W}{I}\right) \qquad \text{Eq. C5.3}$$

Where:

A_w ≡ area of well capture (m^2);
U_w ≡ pumpage rate from the well (m^3/y); and
I ≡ infiltration rate (m/y).

The generic conceptual model of the surface-water pathway in RESRAD assumes that radionuclides are uniformly distributed in a finite volume of water within a watershed. The default watershed area in RESRAD Version 5.91 is $1x10^6$ m^2 (250 acres). Radionuclides are assumed to enter the watershed at the same time and concentration as in the groundwater. Accordingly, no additional attenuation is considered as radionuclides are transported to the watershed. In the surface water, radionuclides are assumed to be diluted as a function of the size of the contaminated area in relation to the size of the watershed. The RESRAD surface-water conceptual model assumes that all radionuclides reaching the surface water are derived from the groundwater pathway. Thus, transport of radionuclides overland from runoff is not considered. In addition, additional dilution from overland runoff is not considered.

The generic conceptual model of the air pathway in RESRAD uses a constant mass loading factor and area factor to model radionuclide transport. The area factor, which is used to estimate the amount of dilution, relates the concentration of radionuclides from a finite area

Table C5.3 Site Feature and Conditions That May Be Incompatible with the Assumptions in RESRAD

Sites with highly heterogeneous radioactivity; Sites with wastes other than soils (e.g., slags and equipment); Sites with multiple source areas; Sites that have chemicals or a chemical environment that could facilitate radionuclide releases; Sites with soils that have preferential flow conditions that could lead to enhanced infiltration; Sites where the groundwater discharges to springs or surface seeps; Sites where the potential groundwater use is not expected to be located in the immediate vicinity of the contaminated zone; Sites with significant transient flow conditions; Sites with significant heterogeneity in subsurface properties; Sites with fractured or karst formations; Sites where overland transport of contaminants is of potential concern; and Sites with stacks or other features that could transport radionuclides offsite at a higher concentration than onsite.

source to the concentration of radionuclides from an infinite area source. It is calculated as a function of particle diameter, wind speed, and the side length of a square-area source. The conceptual model assumes a fixed particle density, constant annual rainfall rate, and constant atmospheric stability. No radioactive decay is considered. See Chang, *et al.* (1998) for more detail. Tritium and ^{14}C gases are assumed to be uniformly mixed in a constant volume of air above the contaminated zone. RESRAD does not model the transport of tritium and ^{14}C as particulates in the air.

5.3.2.2 Limitations of Site-Specific Computer Codes

In general, the conceptual models within RESRAD and RESRAD-BUILD are expected to provide an acceptable generic representation of site features and conditions. Some specific site features and conditions that may be incompatible with this generic representation are listed in Table C5.3.

At any site where it is known that one or more of these conditions or features are present, the licensee should provide appropriate justification for use of the computer code.

5.4 Generic Examples

5.4.1 Screening

A hypothetical research and development (R&D) facility is authorized to use radiological chemicals through an NRC license. Because the R&D facility plans to discontinue its use of radioactive material, it wants to decommission the facility and terminate its license. A historical site assessment reveals that use of radioactive material were limited to a single building within the facility. The floor area of the facility is estimated to be 560 m^2 (6000 ft^2). The wall area is 430 m^2 (4600 ft^2). In addition, an outside area of roughly 930 m^2 (10,000 ft^2) was used for dry storage of chemicals. A preliminary characterization program has determined that approximately 10 percent of the building floor area and 5 percent of the wall area are contaminated with ^{137}Cs and ^{60}Co. Surficial soils covering an area of approximately 2500 m^2 (27,000 ft^2) are contaminated from windblown dust and runoff from spills in the storage area. The soils are also contaminated with ^{137}Cs and ^{60}Co.

The licensee proposes to use a screening analysis, using DandD, to demonstrate compliance with the license termination rule. A building occupancy scenario is assumed for the building and a residential farmer scenario is assumed for the contaminated soils. Based on what is known about the site, the licensee certifies that the use of the generic conceptual models within DandD is appropriate for the analysis.

5.4.2 Site-specific

A hypothetical manufacturing facility has a former radioactive waste burial area that will be decommissioned for unrestricted release. Radioactively contaminated trash was previously buried in 0.2 m^3 (55-gallon) drums, in trenches covering an area of roughly 2000 m^2 (22,000 ft^2). The trenches, which are roughly 0.9 m (3 ft) deep are covered with 1.2 m (4 ft) of native soil. A review of site operating records show that the radionuclides of concern are natural uranium, enriched uranium, and natural thorium.

Based on information from the local county agricultural extension office and published reports, the geology and hydrogeology at the site are described as follows:

> The surface geology at the site contains 14 to 27 m (46 to 89 ft) of till consisting primarily of fine, silty sand to sandy silt with narrow, discontinuous sand lenses. Sandstone bedrock underlies the unconsolidated till. A shallow unconfined aquifer occurs in the unconsolidated till. The average depth to the water table ranges between three to four meters below the land surface. The mean horizontal hydraulic conductivity is roughly 60 m/y. The average vertical hydraulic conductivity of the till is estimated to be an order of magnitude less. The hydraulic gradient is estimated to range between 0.006 to 0.021. The mean precipitation at the site is roughly 0.8 m/y (30 in/y). The site is located in the reach of a surface water drainage basin that has a drainage area of approximately 500,000 m^2 (5.4 million ft^2).

A residential farmer scenario is assumed as a reasonable future land use. The licensee proposes to use the RESRAD computer code for the dose analysis. Because the contaminated media is trash, an assumption is made that the trash degrades and becomes indistinguishable from soil. In addition, the metal drums are assumed to have degraded away. Given the relative short lifespan for metal drums and the long half-life of the radionuclides, this should be a reasonable assumption. The cover is also assumed to be breached through the construction of a basement for the house. The contaminated soil is assumed to be uniformly mixed with the excavated cover. Because the trash is assumed to be indistinguishable from soil, it is also assumed that once the cover is breached the future hypothetical farmer will not recognize the contaminated material as contaminated. The licensee also assumes that the hypothetical future well is located at the center of the contamination because of limited bases for assuming otherwise.

The licensee determines that the other aspects of conceptual models within RESRAD are acceptable for analyzing the problem.

6.0 CRITERIA FOR SELECTING COMPUTER CODES/MODELS

6.1 Introduction

Dose assessment commonly involves the execution of numerical model(s) that mathematically represent the conceptual model of the contaminated site (see Section 5.1). The numerical models used to implement the mathematical equations are usually linked via the conceptual model and codified in a software package known as "the code." The words "code" and "model" are frequently used to express the software package, including the embedded numerical models or the specific models contained in the code. For example, "DandD code" may refer to the software package, including the associated exposure models (e.g., the water- use model, food-ingestion pathway model, inhalation-exposure model, etc.) embedded in the code. The "DandD model" may also refer to DandD software, the DandD conceptual model, or to any of the numerical models, or the group of models used in the code (e.g., DandD groundwater model). Within the context of this SRP, the word "code" shall refer to the software package and the associated numerical models. However, the word "model" shall refer to the mathematical representation of the conceptual model, including representation of the specific exposure scenario and pathways. This section describes the process and criteria used in selection of codes and models for the dose assessment.

The codes and models used in the dose assessment can be either generic screening codes/models or site-specific codes/models. Regardless of the intent of the use of the code/model (e.g., for screening or site-specific analysis), staff should ensure that the dose assessment codes/models and the associated databases are properly documented and verified in accordance with a rigorous QA/QC criteria which is acceptable to the NRC. Currently, the only acceptable generic screening code is DandD Version 2.0. As indicated in Section 2.0, other generic codes/models may also be acceptable on a case-by-case basis. Staff should assess the QA/QC documentation and the level of conservatism of the alternate generic code/model. In addition, staff should review the comparability with the DandD code assumptions and scenarios, as well as its compatibility with the site conceptual model. If site-specific models/codes are used, a justification of the conceptual model should be provided (see Section 5.3.2). Staff should also review the source-term model(s), the transport models, the exposure models, and the overall dose models.

This section describes the generic issues associated with the selection of the screening and site-specific codes/models that staff may encounter, and recommends approaches and criteria, for staff acceptance of the codes/models. In addition, this section presents as generic description of the two common dose assessment codes, DandD Screen and RESRAD/RESRAD-BUILD. These codes have been, or are being, developed, or modified, by the NRC. In addition, these codes have been used by staff and licensees for demonstrating compliance with the dose criteria in Part 20, Subpart E. To help staff understand the dose modeling review process, examples will be provided (when the newly developed codes are completed), to demonstrate the use of DandD, Version 2.0 and probabilistic RESRAD/RESRAD-BUILD codes.

6.2 Issues in Selection of Computer Codes/Models

The major issues associated with the selection of computer codes/models include:

1. Generic criteria for the selection of computer codes/models: This issue pertains to the staff's review criteria of code aspects related to QA/QC requirements, specifications, testing, verification, documentation, interfacing, and other features related to uncertainty treatment approaches;

2. Acceptance criteria for selection of site-specific codes/models: This issue pertains to the staff's review of additional specific requirements for the justification of the use of the conceptual model, the numerical mathematical models, the source-term model and its abstraction, and the transport and exposure pathway models;

3. Options for selection of deterministic or probabilistic site-specific codes: This issue pertains to the staff's review of the justification to support the decision to use either of these two approaches.

Some may be unfamiliar with NRC's newly developed models and codes. Therefore, a generic description of the DandD Version 2.0 is presented below to familiarize staff with this code. Further, the rationale for development of DandD Version 2 and the issue of excessive conservatism in DandD Version 1 are also addressed. A description of the inherent excessive conservatism in DandD model and approaches to minimize such excessive conservatism, using DandD Version 2, site-specific input data, or use of other models/codes is included.

The NRC also sponsored development of the probabilistic RESRAD (Version 6.0) and RESRAD-BUILD (Version 3.0) codes for site-specific analysis. A brief description of these two codes and generic steps used in code execution are included to familiarize staff with these two newly developed codes. The information should also help staff review of input/output data and how the codes could be executed to demonstrate compliance with the dose criteria in Part 20, Subpart E.

For site-specific analysis, staff should accept any model or code that meets the criteria described in Sections 6.3.1 and 6.3.2. However, staff is expected to conduct a more detailed and thorough review of less common codes/models (e.g., codes other than DandD, and RESRAD), specifically those developed by licensees. Staff review of other codes (e.g., other than common codes like DandD and RESRAD) is briefly discussed in Section 6.3.3.

Selection of appropriate models/codes for complex sites may also present challenges. For example, sites with multiple source terms, with significant groundwater/surface-water contamination, or sites with existing off-site releases, may require more advanced codes/models than common codes such as DandD or RESRAD. Complex sites may also include sites with engineered barrier(s), or with complex geological conditions like highly fractured geologic formations. Because of site complexity and variability, there is no standard dose analysis review criteria for these sites. Section 6.3.4 presents generic examples for staff to use to categorize a site as a "complex site," requiring further site-specific analysis to evaluate site performance.

6.3 Recommended Approach

6.3.1 Generic Criteria for Selection of Codes/Models

The generic criteria under this subsection pertain to staff review of codes/models other than commonly used codes, specifically, those developed or modified by the NRC (i.e., other than DandD and RESRAD/RESRAD-BUILD). Staff should use the generic criteria when the codes/models have no readily available documentation of testing, verification, and QA/QC review. In this context, staff should use the following generic criteria in reviewing the codes/models selected for the dose assessment:

1. Staff should review the adequacy and completeness of the database available regarding QA/QC aspects of the code/model. The QA/QC database should be comparable to NRC's QA/QC requirements [NUREG/BR-0167 (Douglas, 1993) and NUREG-0856 (NRC, 1983)]. The QA/QC should include information regarding mathematical formulation, code/model assumptions, consistency of the pathways with the assumed conceptual model(s) used in the code, and accuracy of the software to reflect the model's mathematical formulation and correct representation of the process or system for which it is intended;

2. Staff should ensure that the software used for the code are in conformance with the recommendations of IEEE Standard 830-1984, IEEE Guide for Software Requirement Specifications;

3. Staff should review the adequacy and appropriateness of the code/model documentation with regard to: (a) software requirements and intended use; (b) software design and development; (c) software design verification; (d) software installation and testing; (e) configuration control; (f) software problems and resolution; and (g) software validation;

4. For uncommon codes/models, staff should review code data including: (a) a software summary form; (b) a software problem/change form; (c) a software release notice form; and (d) a code/model user's manual, which covers code technical description, software source code, functional requirements, and external interface requirements (e.g., user interface, hardware interface, software interface, and communication interface), if necessary;

5. Staff should review the conceptual model of the selected code to ensure compatibility with the specific site conceptual model, including the pathways and the exposure scenario. The source-term assumptions of the selected code should also be compatible with site-specific source term. Staff may accommodate minor modifications in the source-term conceptual model, as long as the basic model assumptions are not violated;.

6. Staff should review the selected code to verify that the exposure scenario of the selected code is compatible with the intended scenario for the site. For example, models/codes designed for the on-site exposure scenario may not be appropriate for

assessment of an off-site receptor scenario or a scenario to estimate an off-site collective public dose;

7. Staff should review the selected model/code formulation to account for radionuclide decay and progenies. The code should have proper and timely formulation, as well as linkages of decay products with the receptor location and the transport pathways, via corresponding environmental media;

8. Staff should examine documentation of the selected code/model performance; specifically, test and evaluation, as well as code comparison with commonly used (accepted) codes and models (e.g., DandD and RESRAD codes). Staff should also review documentation on code/model verification, if available, to support decisions for code acceptance;

9. Staff should review code/model features regarding sensitivity/uncertainty analysis to account for variability in selection of input parameters and uncertainty in the conceptual model and multiple options for interpretation of the system.

6.3.2 Acceptance Criteria for Selection of Site-Specific Codes/Models

This issue involves the staff's review of additional requirements supporting the justification for using the conceptual model, the numerical mathematical models, the source-term model and its abstraction, and the transport- and exposure-pathway models.

Conceptual Models

Staff review shall compare the conceptual model for the site with the conceptual model(s) in the selected code, to ensure compatibility with site-specific physical conditions and pathway assumptions for the critical group receptor (see Section 5.3.2).

Numerical Mathematical Models

Staff should review the equations used in the code to implement the conceptual model and the numerical links between mathematical models to ensure correctness and consistency. For codes developed or modified by the NRC (e.g., DandD, RESRAD & RESRAD-BUILD), staff review would be minimal because these codes were revised by staff and examined early for consistency with NRC's QA/QC requirements. For less commonly used codes, or codes developed locally by user(s), staff should verify the numerical mathematical models, including the numerical links between these models. In this context, staff may examine, if necessary, each mathematical model used for the specific transport-exposure pathway, to ensure that the code is designed for its intended use.

Source-Term Models

Staff should review the source-term model(s) used for the specific site. In this context, staff review should include the following source-term aspects:

Building occupancy scenario source term: Staff should review the historic site assessment and other relevant data regarding extent of the source term and its depth [e.g., within 1 to 10 mm (0.04 to 0.4 in) deep into the building surface or more]. Based on this review, staff should identify the source term as surficial or volumetric source. In addition, staff should examine assumptions made for the loose/fixed fractions of the source. Contamination sources on surfaces that are not integral parts of the building (e.g., equipment, pipes, and sewer lines) should be addressed separately, because the applicable model and exposure scenario could be different. Therefore, source-term model assumption for such surfaces should be reviewed on a case-by-case basis. Staff should also review the source term regarding radionuclide mixture and if a constant ratio is assumed in the dose analysis. Staff should determine if surrogate radionuclides are used in the source-term model assumption. The latter two situations may require additional staff verification of the source-term model and review of consistency with the intended final survey methodology. Staff should also review the use of multiple sources (e.g., multiple rooms) . Certain codes may use advanced source-term assumptions, such as two to three rooms, with multiple-story buildings. The source-term under these conditions allows for source depletion due open air circulation and common ventilation. For example, the RESRAD-BUILD code model uses two- or three-room models with two- or three-story buildings, allowing for air exchange within the rooms, and source-term depletion. The indoor air- quality model (e.g., building ventilation and infiltration), and the indoor air- concentration model, as well as the adaptation of the air-quality model in RESRAD-BUILD code should be reviewed, to ensure consistency with the site-specific condition. Input parameters associated with these models should be verified. Staff may accept such site-specific source-term models after an assessment of the compatibility of the source-term model with the conceptual model of the site. Staff should also review the physical parameters defining the source term, to ensure consistency with site-specific conditions, and the occupancy parameters, to ensure consistency with the exposure scenario.

Resident Farmer Scenario Source Term: Staff shall examine the source- term information to identify the source as surficial or volumetric, to ensure consistency with the model in the selected code. Staff shall also review the vertical and horizontal extent of contamination, to verify the model assumed for the contaminated zone (CZ), and to determine if there is subsurface and/or groundwater contamination at the site. For surficial source terms, DandD model and other codes like RESRAD (assuming appropriate thickness) may be used. For volumetric sources, DandD cannot be used directly before simulation of the volumetric source into a surficial source. The source-term model should also be reviewed, to examine the contaminated area and its shape, to check for possible correction for the area and/or for geometry of the source. Staff shall also determine if a cover or a barrier is assumed at the top of the CZ, and the justification for such an assumption. The cover and/or barrier issue will be examined within the context of the institutional control assumptions and the physical performance of the cover or the barrier within the compliance period (e.g., 1000 years).

Staff shall also review the physical and chemical form of the source-term to evaluate the soil leaching model assumption and the two components, sorbed mass and leached mass of the source. This review should help assess the source mass-balance model and the transport model within the concerned environmental media. In addition, review of these source-term aspects would help establish consistencies for the selection of relevant parameters. Staff should also review source-term horizontal distribution and homogeneity, and variation of source concentration with depth. Staff should use either an upper-bounding value for modeling the thickness or an area-weighted approach to calculate the representative thickness. In certain cases, staff may evaluate the need for modeling of multiple sources and the need for more advanced subsurface source-term modeling.

Transport Models

The transport models simulate transport mechanisms of contaminants from the source to the receptor. Staff should review transport models for consistency and compatibility with respect to: a) the source term; b) the exposure scenario defined for the critical group receptor; and c) the simplified conceptual model, which describes site-specific physical conditions. The transport models may include diffusive and advective transport of contaminants via air, surface water, and groundwater. The transport models can be overly simplified, using simple conservative assumptions such that minimal characterization data would be required to execute the model(s). Transport models can also be very complex, requiring advanced mathematical derivation and extensive site-specific, or surrogate, data about the site.

For the building occupancy scenario, the associated transport models (e.g., transport models for ingestion, inhalation, and direct exposure pathways) of DandD code are simple and conservative. For example, the ingestion pathway depends on the effective transfer rate of the removable surface contamination from surfaces to hands and from hands to mouth. The inhalation transport model depends largely on mechanical disturbance of the contaminated surface, resuspension of contamination in the air, and subsequent breathing of contaminated air. The external dose formulation assumes exposure from a non-uniform source of contamination on the walls, ceiling, and floor of a room. This model was found to be comparable to the infinite plane source for the building occupancy scenario (Kennedy and Strange, 1992).

For the resident farmer scenario, the associated DandD transport models include models of contaminants transport to groundwater, to surface water (e.g., three-box model that relies on transfer of contaminate through leaching), and to air (e.g., through dust mass loading and indoor resuspension). Transport models of contaminants via the air include dust loading, resuspension of contaminated soil, and use of mass loading factor for deposition. Transfer of contaminants from the soil/water to plants, fish, animals, and animal products are calculated using a water-use model, along with transfer factors, translocation factors, and bio-accumulation factors. For carbon and tritium, separate models were used, as described in NUREG/CR-5512, Volumes 1, 2, and 3.

The RESRAD model assumes a volumetric source, with an idealized cylindrical shape of the CZ, and allows for a cover at the top of the CZ, if necessary. See Section 5.3.2.1.2 for details of RESRAD models and assumptions.

In general, staff should conduct a review of the selected code, with respect to transport models and appropriateness of such models with respect to the site-specific conditions (e.g., area, source, unsaturated zone, and aquifer conditions). In addition, staff should review, for compatibility and consistency, the transport model assumptions and the generic formulation pertaining to the applicable pathways of the critical group exposure scenario. The extent of transport model review depends on the familiarity of NRC staff with these models. Because certain codes/models were commonly used and were developed or modified by the NRC (e.g., DandD, RESRAD, RESRAD-BUILD, and MEPAS), staff is more familiar with such common codes. Therefore, staff review of these common codes/models, would be less than staff review of a less common codes/model developed by users or other parties. Staff review should also include updated new models or code versions and studies regarding code/models testing, comparison, and verifications.

RESRAD-BUILD is a more advanced code than DandD, because it employs multiple sources and more advanced particulate air transport models. In other words, each contaminated location may be considered a distinct source. Depending on its geometric appearance, the source can be defined either as a volume, area, or as a point source. RESRAD-BUILD depends on erosion of the source material and transport of part of its mass into the indoor air environment, resulting in airborne contamination. The RESRAD-BUILD model differs from DandD because it assumes air exchange among all compartments of the building. In other words, the model assumes that the airborne particulates are being loaded into the indoor air of the compartment and then transported to the indoor air of all compartments of the building. In addition to air exchange between compartments, the indoor air model also simulates air exchange between compartments and the outdoor air. Descriptions of models pertaining to indoor air quality, air particulate deposition, inhalation of airborne dust, and ingestion of removable materials and deposited dust, were documented in Argonne National Laboratory report “ANL/EAD/LD-3,” (ANL, 1994). The exposure pathways in the RESRAD-BUILD code include: a) the external exposure to radiation emitted directly from the source and from radioactive particulates deposited on the floors, and exposure caused by submersion from radioactive particulates; b) inhalation of airborne radioactive particulates; and c) ingestion of contaminated material directly from the source, and airborne particulates deposited onto the surface of the building.

Exposure Pathway Models

The exposure pathway models pertain to the formulation of the links between the radiological contamination source, the transport of contaminants within environmental media, the critical group receptor location, and behaviors of the receptor that lead to its exposure to radiological contamination through direct exposure, inhalation, and ingestion of contaminated water, soil, plants, crops, fish, meat, milk, and other dairy products. Staff should review the conceptual model(s) that describe the human behaviors that lead, or control, the amount of receptor exposure. Therefore, the occupational, behavioral, and metabolic parameters describing these models should be reviewed and compared with the default model scenarios and associated parameters. Staff should review exposure model(s) and associated parameters to ensure conservatism, consistency, and comparability with site-specific conditions and scenario assumptions. NUREG/CR-5512, Volumes 1, 2, and 3, and Section 7 of this TBD, provide detailed information regarding default parameters and approaches for changing parameters in dose modeling analysis.

Intakes and Direct Exposure Dose Conversion Factors

Staff should review the dose conversion factors for inhalation and ingestion, to ensure that the factors used are those developed by the U.S. Environmental Protection Agency, published in Federal Guidance Report No. 11 (EPA, 1988). Similarly, staff review should ensure thatf EPA's external dose factors (e.g., for an infinite surface with soil contamination to a depth of approximately 15 cm (4 in), published in Federal Guidance Report No. 12 (EPA, 1993) were used. These dose factors were selected to ensure consistency of the dosimetry models used in deriving these factors with the NRC's regulations in Part 20.

6.3.3 Options for Selection of Deterministic or Probabilistic Site-Specific Codes

Licensees may select either a deterministic analysis approach or a probabilistic approach for demonstrating compliance with the dose criteria in 10 CFR Part 20, Subpart E. Therefore, staff should review the dose assessment that might be derived using either of these two approaches. However, the deterministic approach may require more elaborate justification of code input parameter values and may require further analysis of doses using upper/lower bounding conditions. Section 8.3.2 provides a detailed description of a staff review for deterministic and probabilistic analysis.

6.3.4 Modeling of Subsurface Source-Term Contamination

For subsurface contamination (contamination at depths >15-30 cm (6-12 in)), staff shall review existing historical site data (including previous processes or practices) and site characterization data, to establish an adequate conceptual model of the subsurface source, specifically the horizontal and vertical extent of contamination. Section 3.3.3 describes approaches for subsurface source-term abstraction for dose modeling analysis.

6.3.5 Generic Description and Development of DandD Versions 1.0 and 2.0 Code and Examples of DandD Code Application

Two scenarios are implemented in DandD, the building occupancy and the residential scenario. The building occupancy scenario relates volume and surface contamination levels in existing buildings (presumably released after decommissioning for unrestricted commercial or light-industrial use) to estimates of the total effective dose equivalent (TEDE) received during a year of exposure, with the conditions defined in the scenario. The exposure pathways for this scenario include external exposure, inhalation exposure, and secondary ingestion pathways.

The more complex and generalized residential scenario is meant to address sites with contamination in soils and groundwater. The exposure pathways include external exposure, inhalation, and ingestion of contaminated crops, meat, soil, plants, fish, and drinking water (Kennedy and Strenge, 1992). A generic water-use model was developed to permit the evaluation of the annual TEDE from drinking water from wells and from multiple pathways associated with contaminated soil. Section 5.3.1 describes the three-box water-use model of DandD code. .

6.3.5.1 Development Documentation of DandD Software (Version 1)

The DandD software assists NRC staff, and licensees who must decontaminate lands and structures, in determining the extent of decommissioning required to allow unrestricted release of the properties. The DandD software automates the scenarios, models, mathematical formulations, and assumptions documented in NUREG/CR-5512, Volume 1 (Kennedy and Strenge, 1992). On August 20, 1998, NRC issued, the screening computer code DandD Version 1.0, to calculate the screening values for demonstration of compliance with the radiological criteria for the license termination rule in Part 20, Subpart E. The source code and the user manual for DandD Version 1.0 are documented in NUREG/CR-5512, Volume 2 (Wernig, et al., 1999). The default parameter values in DandD Version 1.0 have been defined through a systematic process of assessing the variability of each parameter across the U.S. and defining default values that produce generic dose estimates that are unlikely to be exceeded at any real site (Beyeler, et al., 1999). NRC staff tested and evaluated the code's performance and conducted code/model comparisons with the deterministic RESRAD and RESRAD-BUILD codes (Haaker, et al., 1999). Staff also solicited licensees and stakeholders to examine DandD Version 1.0 performance for real sites. Staff and users identified several areas where DandD Version 1.0 may be overly conservative.

6.3.5.2 Excessive Conservatism in DandD Version 1 Methodology and Parameters

As indicated above, DandD, Version 1.0, is a deterministic screening code, with a single set of default parameters, which is an acceptable screening tool to calculate the screening values to demonstrate compliance with the dose limit in Part 20, Subpart E. The staff has examined several areas where the DandD code may be overly conservative. These areas include: (1) reevaluation of the resuspension factor (RF); (2) reevaluation of default parameter selection; (3) model comparison study (Haaker, et al., 1999); and (4) groundwater model comparison study (Cole, et al., 1998). A technical basis document for revision of the RF is still under review and development.

Version 1.0 of the DandD code uses a deterministic set of default parameters. These deterministic values, however, were selected from a range of possible values, rather than by establishing single bounding values. A probability density function (PDF) was established for the range of values for each parameter in the DandD code. A single set of default parameters was selected by probabilistically sampling the PDFs for each of the parameters, to maintain a 90 percent confidence level that doses would not exceed the dose limit for a combination of all radionuclides. A detailed discussion of the way the default parameters were selected is contained in NUREG/CR-5512, Volume 3.

This method of selecting the default parameter set tends to overestimate the dose. That is, if the default parameter set were selected for a single radionuclide rather than for all radionuclides, the dose calculated using DandD with the single radionuclide default parameter set would, in most cases, be lower than with the "all radionuclides" default parameter set currently in Version 1.0 of the DandD code. For example, the DCGL corresponding to 0.25 mSv/y (25 mrem/yr) for ^{137}Cs using the "all radionuclide" default parameter set is approximately 37 Bq/kg (1 pCi/g); while the DCGL using the "single radionuclide" default parameter set is approximately 407 Bq/kg (11 pCi/g). The results of the results of DandD, Version 1.0 using the two default parameter sets are discussed in a Letter Report from Sandia National Laboratories, dated January 30, 1998. To improve this area, Version 2.0 of the code was developed to calculate a unique default parameter set based on the specific radionuclides in the source term.

To evaluate the overall conservatism in DandD, a study was conducted to compare the DandD code with the RESRAD and RESRAD-BUILD codes for both the residential and building occupancy scenarios, respectively. This comparison is documented in NUREG/CR-5512, Volume 4 (Haaker, et al., 1999). In summary, the models in the DandD codes appeared appropriate for screening (e.g., simplistic, and defensible with minimal data). The default soil mass loading factor for foliar deposition for DandD appears to be too high. The soil-to-plant transfer factors, distribution coefficients, and bio-accumulation factors for certain radionuclides appear to be too conservative. This conservatism is mainly caused by the DandD Version 1.0 approach for selection of the solution vector, to generate a single set of default parameters for all radionuclides. Therefore, the deterministic DandD code in Version 1.0 has been revised aa a probabilistic code, DandD, Version 2.0. An arithmetic error was also found in the default parameter value of the ^{35}S radionuclide. Also, the code does not model tritium and carbon-14 realistically. This could lead to an underestimation of doses where groundwater is not a predominate pathway. It was also determined that RESRAD and RESRAD-BUILD may be better suited to deal with "hot spots."

Another area where staff evaluated the excess conservatism in the DandD code was the groundwater model. The basic conceptual groundwater model in DandD was described in NUREG/CR-5512, Volume 1. This groundwater model was compared to two more realistic groundwater models in NUREG/CR-5621 (Cole, et al., 1998). These two models are: the STOMP code, as the realistic vadose zone model, and the CFEST code, as the realistic aquifer compartment model. The study concluded that the maximum groundwater concentration increased with the number of vadose zone compartments for the DandD model, and that it exaggerated vadose zone dispersion. The study recommended that the maximum vadose zone compartment (layer) thickness in the DandD code should be set to 1 m (3.3 ft). This could be a problem where the vadose zone is thicker than 10 m (33 ft), because the DandD code only allows 10 vadose zone compartments. In general, the study concluded that the DandD model described realistic and conservative representations, of an aquifer and vadose zone, that are appropriate for site assessment. However, it was indicated that, for radionuclides with short half-lives compared to the vadose zone transit time, the DandD model may not be adequate.

6.3.5.3 Development of Probabilistic DandD Version 2

Because of the overly conservative approach resulting from the artifact in the way the single default parameter set was selected in DandD Version 1.0, staff has developed a probabilistic DandD, Version 2.0. The screening DandD Code Version 2.0 updates, improves, and significantly enhances the capabilities of Version 1.0. In particular, Version 2.0 allows full probabilistic treatment of dose assessments, whereas Version 1.0 embodied constant default parameter values and only allowed deterministic analyses. DandD implements the methodology and information contained in NUREG/CR-5512, Volume 1, as well as the parameter analysis in Volume 3, that established the probability distribution functions (PDFs) for all of the parameters associated with the scenarios, exposure pathways, and models embodied in DandD.

Finally, DandD Version 2.0 includes a sensitivity analysis module that assists licensees and NRC staff to identify those parameters in the screening analysis that have the greatest impact on the results of the dose assessment. Armed with this information and the guidance available in NUREG-1549, licensees are able to make informed decisions regarding the allocation of resources needed to gather site-specific information related to the sensitive parameters. When cost and the likelihood of success associated with acquisition of this new knowledge are considered, licensees are better able to optimize the costs to acquire site data that allow more realistic dose assessments that, in turn, may lead to demonstrated and defensible compliance with the dose criteria for license termination.

6.3.5.4 Example of DandD Code Applications

Non-Fuel-Cycle Nuclear Facilities and Generic Research and Development Facilities

NRC licensees use radioactive materials for an extremely broad range of activities. These might include handling byproduct, source, and/or special nuclear materials not involved in electric power production; use of radioisotopes in universities, medical institutions, and laboratories; source manufacturers; various industrial users; and R&D facilities. Many of these facilities use sealed sources or small amounts of short-lived radionuclides in their applications. Levels of exposure and contamination are often low or negligible, but can be substantial in some operations.

Sealed source nuclides may include ^{60}Co; ^{137}Cs; ^{125}I; ^{192}Ir; ^{90}Sr; and ^{241}Am. Sealed sources are designed and tested to prevent leakage, and as such, contamination of structures and soils is generally not expected from routine operations. When low-probability leakage events do occur, the contamination is localized and remediation is straightforward. Sealed source manufacture can involve significant operations that result in localized contamination.

Short-lived nuclides, primarily licensed for medical diagnostics, may include ^{99m}Tc; ^{131}I; and ^{123}I. The nature of operation of these short-lived materials usually means contamination of structures and soils is unlikely and contamination is often confined to localized areas in buildings. Remediation is relatively easy and many of these materials are allowed to “decay-in-storage.” Demonstrating compliance for sealed sources and short-lived materials after clean-up may include a final survey and calculation of the reduction of activity after clean-up and decay-in-storage.

Case 1: Localized building contamination from ^{60}Co and ^{137}Cs.
(Information will be provided after completion of DandD Version 2.)

Case 2: Greater levels of contamination from ^{90}Sr and ^{241}Am leakage.
(Information will be provided after completion of DandD Version 2.)

Power, Research, and Test Reactors

The major reactor facilities can involve complex patterns of contamination from a variety of normal and off-normal operations. This example is limited to use of the residential scenario to analyze the impact of releases of ^{60}Co, ^{90}Sr, and ^{137}Cs in various configurations.

Case 1: General contamination of soils.
(Information will be provided after completion of DandD Version 2.)

Case 2: Limited contamination in a small area near the house.
(Information will be provided after completion of DandD Version 2.)

Case 3: General contamination of the garden.
(Information will be provided after completion of DandD Version 2.)

Nuclear Fuel Cycle Facilities

These facilities can result in large areas of contamination by a number of long-lived radionuclides. The following examples will exercise and demonstrate the use of DandD for these applications.

Case 1: Natural uranium contamination in fuel fabrication.
(Information will be provided after completion of DandD Version 2.)

Case 2: Wide-spread ^{230}Th and ^{226}Ra contamination.
(Information will be provided after completion of DandD Version 2.)

6.3.6 Generic Description of Deterministic RESRAD/RESRAD-BUILD Codes, Development of Probabilistic RESRAD/RESRAD-BUILD Codes, and Examples of Codes Application

6.3.6.1 Generic Description of Deterministic RESRAD & RESRAD-BUILD Codes

The deterministic RESRAD and RESRAD-BUILD computer codes were developed by Argonne National Laboratory under the sponsorship of the U.S. Department of Energy. These two codes are pathway analysis models designed to evaluate potential radiological doses to an average member of the specific critical group. RESRAD code uses a residential farmer scenario (Yu, et al., 1993) with nearly identical exposure pathways as the DandD residential scenario described in NUREG/CR-5512, Volume 1 (Kennedy and Strenge, 1992). The RESRAD-BUILD code uses a building occupancy scenario that covers all exposure pathways in the DandD building occupancy scenario, plus pathways corresponding to external exposures from air submersion and deposited material, and to ingestion of deposited material. Brief descriptions of RESRAD and RESRAD-BUILD codes and conceptual models were presented in Sections 2 and 5. For detailed descriptions of these two deterministic codes, the reader is referred to Yu, et al. (1993) and Yu, et al. (1994). The two deterministic codes were widely used by NRC staff and licensees to estimate doses from radioactively contaminated sites and structures. These two codes were selected because they possess the following attributes:

1. The software has been widely accepted and there is already a large user base among staff and licensees;

2. The models in the software were designed, and have been applied successfully, to more complex physical and contamination conditions than DandD code; and

3. Verification and validation of these two codes are well-documented (Yu, 1999; NRC, 1998c).

It should be noted that the RESRAD code has been widely used and tested by national and international agencies and has gone through verification (HNUS, 1994), dose model comparison (Haaker, et al., 1999; EPRI, 1999) and benchmarking (DOE, 1995). Therefore, RESRAD and RESRAD-BUILD codes were continuously developed and updated with new code versions. The latest deterministic code versions that were available before development of probabilistic codes were RESRAD 5.91 and RESRAD-BUILD 2.82.

6.3.6.2 Development of Probabilistic RESRAD & RESRAD-BUILD Codes

The NRC has adopted the risk-informed approach in assessing impacts on the health and safety of the public from radioactive contamination. Therefore, the NRC tasked ANL to develop parameter distribution functions and parametric analysis for these commonly used codes. RESRAD 5.91 and RESRAD-BUILD 2.82 Versions were frozen for development of the probabilistic codes. Therefore, ANL was tasked to develop necessary computer modules for conducting probabilistic dose analysis. As part of this effort, external modules equipped with probabilistic sampling and analytical capabilities have been developed for RESRAD and RESRAD-BUILD codes. The modules are also equipped with user-friendly input/output interface features, to accommodate numerous parameter distribution functions, and to fulfill results display requirements. The code and the interface modules have been designed to operate on the Microsoft Windows™ 95, 98, and NT platforms. The newly developed RESRAD Version is 6.0 and RESRAD-BUILD is 3.0. Probabilistic parametric data distributions were developed through the following steps:

Step 1: Parameter Characterization

The parameters were classified relative to their physical, behavioral, or metabolic attributes. A parameter that would depend on the receptor's behavior and the scenario definition was classified as a behavioral parameter. A parameter representing a metabolic characteristic that is independent of the scenario is classified as a metabolic parameter. Any parameter that depends largely on the physical and natural attributes of the site and typically is independent of the receptor behavior and the scenario is considered a physical parameter.

Step 2: Parameter Ranking

Parameter rankings were classified into three categories: level 1 (high-priority); level 2 (medium-priority); and level 3 (low-priority). These levels of ranking were based on: a) relevance of the parameter in dose calculations; b) variability of the dose as a result of changes in parameter value; c) parameter type (e.g., physical, behavioral, or metabolic); and d) availability of data on the specific parameter. Based on this ranking criteria, 14 parameters were ranked level 1; 59 level 2; and 120 parameters level 3 for both RESRAD and RESRAD-BUILD codes.

Step 3: Parameter Distribution

Parameter distributions were developed for all 73 parameters of levels 1 and 2 and for very few level 3 parameters. The data were obtained from published information and data representative of a national distribution, Correlations among parameters were also studied. For the parameter distribution analysis, the residential farmer and the building occupancy scenarios were used for RESRAD and RESRAD-BUILD codes, respectively. These two scenarios serve as baseline for this analytical process. For RESRAD code, the peak TEDE dose to the average member of the critical group within 1000 years was used. For RESRAD-BUILD code, the initial dose (e.g., at time 0) was assumed.

The probabilistic analysis was performed by using the stratified sampling of the Latin Hypercube Sampling (LHS) method for collection of input parameter distributions. The LHS method provides an appropriate process for multi-parameter sampling. The dose estimates are generated at different quantile values (e.g., 50^{th} or 90^{th} percentile). The spread of dose was identified by the ratio of dose at the 99^{th} percentile to the dose at the 50^{th} percentile for the residential scenario and by the ratio of dose at the 95^{th} percentile to the dose at the 50^{th} percentile, for the building occupancy scenario. Regression analysis was used to identify sensitive parameters . For example, the partial rank correlation coefficients (PRCCs) and the standardized rank regression coefficients (SRCCs), were used in the residential and building occupancy scenarios, respectively. The effects of sensitive parameters on the dose distributions were studied for the radionuclides ^{241}Am, ^{14}C, ^{60}Co, ^{137}Cs, ^{3}H, ^{239}Pu, ^{226}Ra, ^{90}Sr, ^{230}Th, and ^{238}U. These radionuclides were selected because they include all pathways and are common for decommissioning facilities. The sensitivities of site-specific parameters on source area and thickness were also analyzed for RESRAD with sources constituting: a) area of 100 m^2 (1080 ft^2) and thickness of 15 cm (6 in); b) area of 2,400 m^2 (25,800 ft^2) and thickness of 15 cm (6 in); and c) area of 10,000 m^2 (107,600 ft^2)and thickness of 2 m (6.6 ft). For RESRAD-BUILD, both surface and volumetric configurations were selected for source areas 36 m^2 (388 ft^2, 200 m^2 (2,150 ft^2) and 900 m^2 (9,690 ft^2). The parameter uncertainty analysis showed that there is no single correlation or regression coefficient (e.g., PRCC, SRCC) that can be used alone to identify generic sensitive parameters for all cases. The coefficients, however, are useful guides to use in conjunction with other aids (e.g., scatter plots and/or further analysis) to identify sensitive parameters. Therefore, site-specific distributions and sensitivity analysis should be conducted as much as practicable.

6.3.6.3 Description of Probabilistic Module Used to Evaluate Dose Distribution

<u>Integration with RESRAD Codes</u>

The probabilistic module is integrated into both the RESRAD and RESRAD-BUILD software packages. The system has been designed so that the details of file, data, and calculation modules are hidden from the user. The high-level details of this system are shown in Figure C6.1. The user can start the programs, specify cases, and run the codes in a manner similar to the previous versions. The probabilistic module input is displayed through either the toolbar or by pressing the “F8" key when the windows focus is on a specific parameter. The output module is displayed through the menu. (See Figure C6.2 for a diagram of this process.) Figure C6.1 shows a diagram illustrating integration of probabilistic modules with RESRAD and RESRAD-BUILD codes.

Procedure for Code Navigation

The procedures for using the probabilistic analysis module are as follows:

1. Users run the standard software interface (i.e., RESRAD or RESRAD-BUILD) to set deterministic values for parameters not involved with probabilistic analysis.

2. Probabilistic analysis is set by finding parameters in the standard interface and pressing the “F8” key. The probabilistic input window with four tab screens will appear. The parameter will be automatically added, with its default distribution, to the list of parameters for probabilistic analysis.

3. If the probabilistic analysis is activated, after running the standard software, the probabilistic runs will begin.

4. After completion of the calculations, the interactive output window will appear so tables and graphics can be created to display results. There is access to both the textual report and the detailed data dump files.

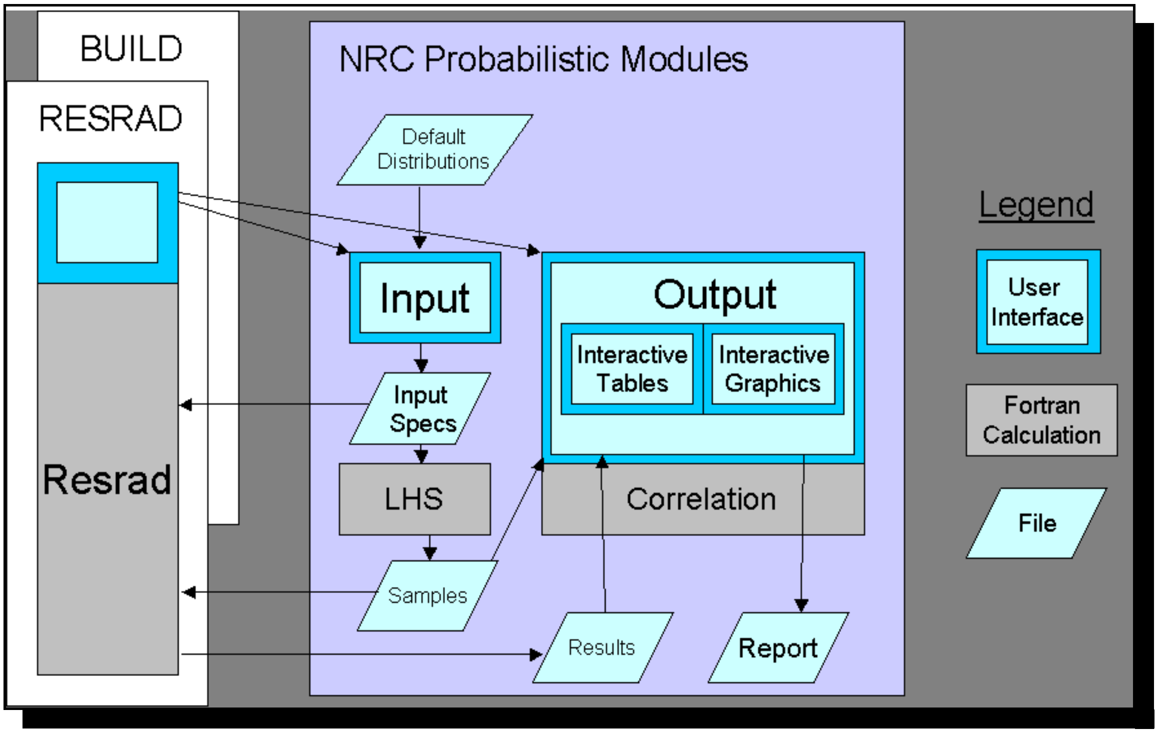

Figure C6.1 Integration of Probabilistic Modules with RESRAD/ RESRAD-BUILD Codes.

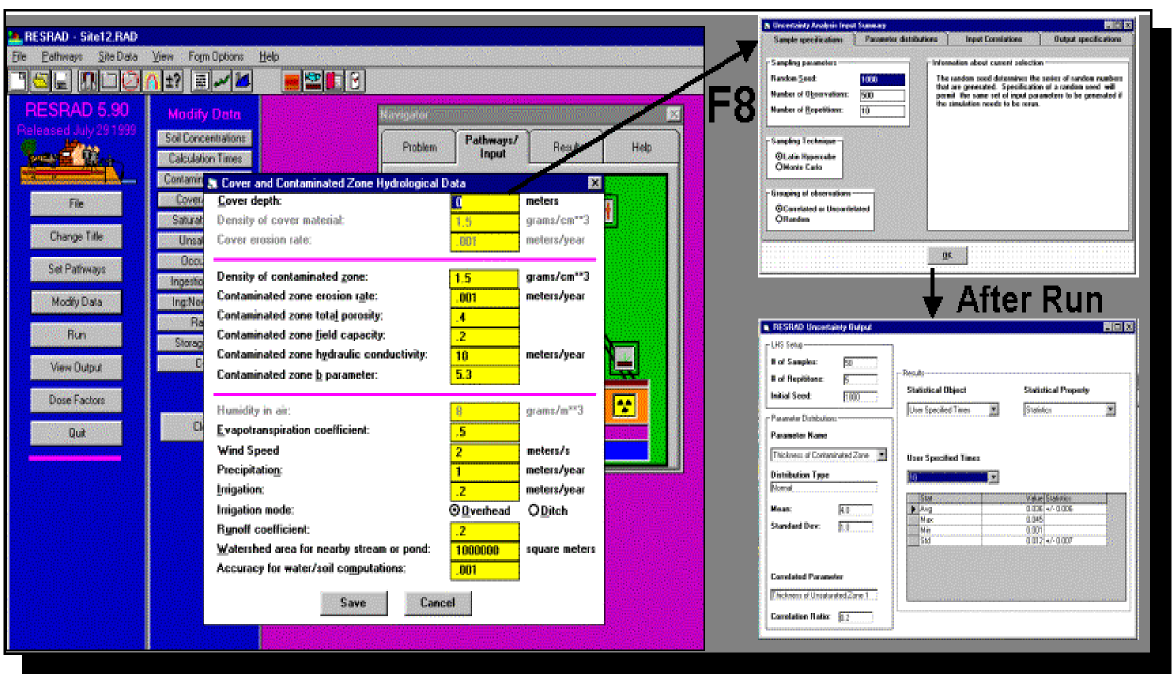

Figure C6.2 Diagram Showing User's Access from RESRAD Interface (left) to Probabilistic Input Window (upper right) and Probabilistic Output Window (lower right).

The probabilistic modules have been designed to be flexible and quite independent of the original RESRAD or RESRAD-BUILD application, yet easily applied and integrated with the application and using previously written software for LHS and correlation analysis.

The input window (see Section 6.3.6.4) takes information from the default distribution database and from user's commands to construct the list of parameters, their distributions and correlations, and general sampling options. At run time, the LHS code is activated to perform the sampling. The code is then run on these samples, and the results are stored for incorporation into textual reports.

6.3.6.4 Input Windows

Sample Specifications

The user is allowed to specify details of the sample generation (Figure C6.3). Included in this specification are the beginning random seed, the number of observations and repetitions, the sampling technique, and the grouping of observations. Detailed information about these options is displayed on the right-hand side of this window as the user navigates through the options. Usually the user will be concerned with the number of observations and repetitions.

Sampling Technique

The LHS option will split the distribution to be sampled into a number of equally probable distribution segments (the number is equal to the desired number of observations) and will obtain one sample at random from within each segment. This procedure ensures that the samples cover the entire range of the distribution. The Monte Carlo option will obtain each of the specified number of samples randomly from within the whole distribution.

Grouping of Observations

Correlated or uncorrelated grouping will order the samples for each variable so that: (1) the correlations between the specified variables are as close as possible to the specified input correlations; and (2) the correlations between the variables that are not specified to be correlated will be as close to zero as possible. Random grouping will group the variables in the order that they were obtained. It is possible that some of the variables so sampled will be correlated just by chance.

Parameter Distributions

The parameter distribution tab screen allows the user to view and edit all currently specified parameter distributions for probabilistic analysis (Figure C6.4). The parameters are listed in the left frame. The detailed distribution properties are shown in the right frame.

Navigation

Navigation to other parameter distributions is achieved by either clicking on the parameter on the left side or using the "Up-Down" arrow control on the left side.

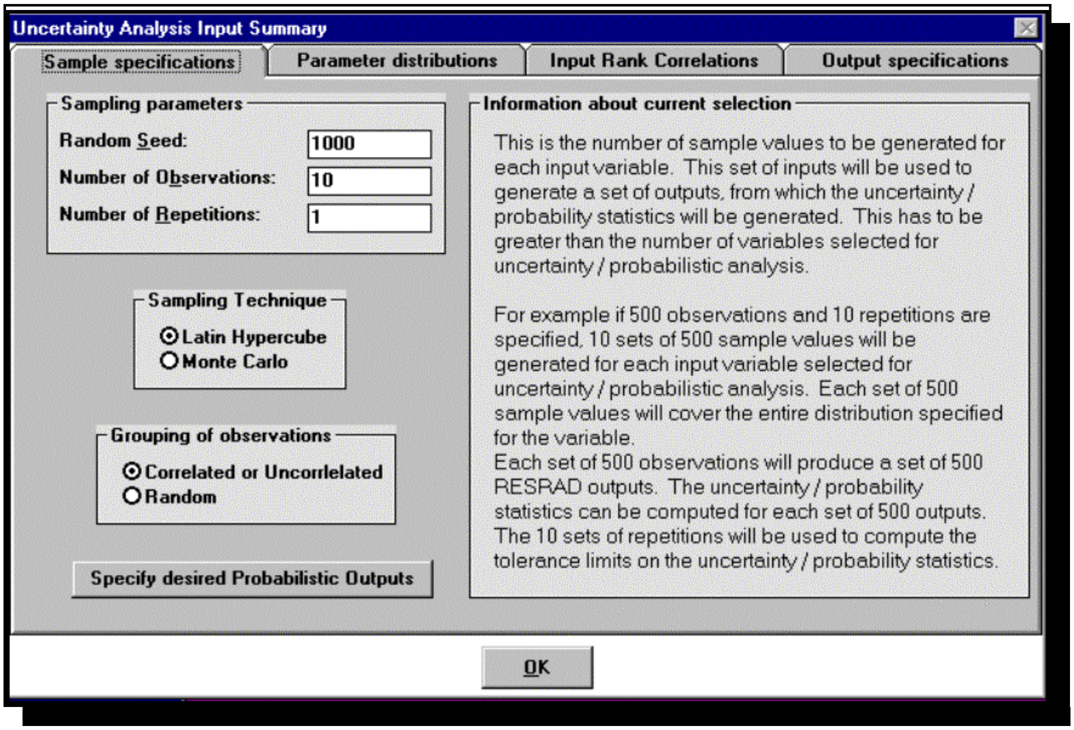

Figure C6.3 Probabilistic Analysis Sample Specification.

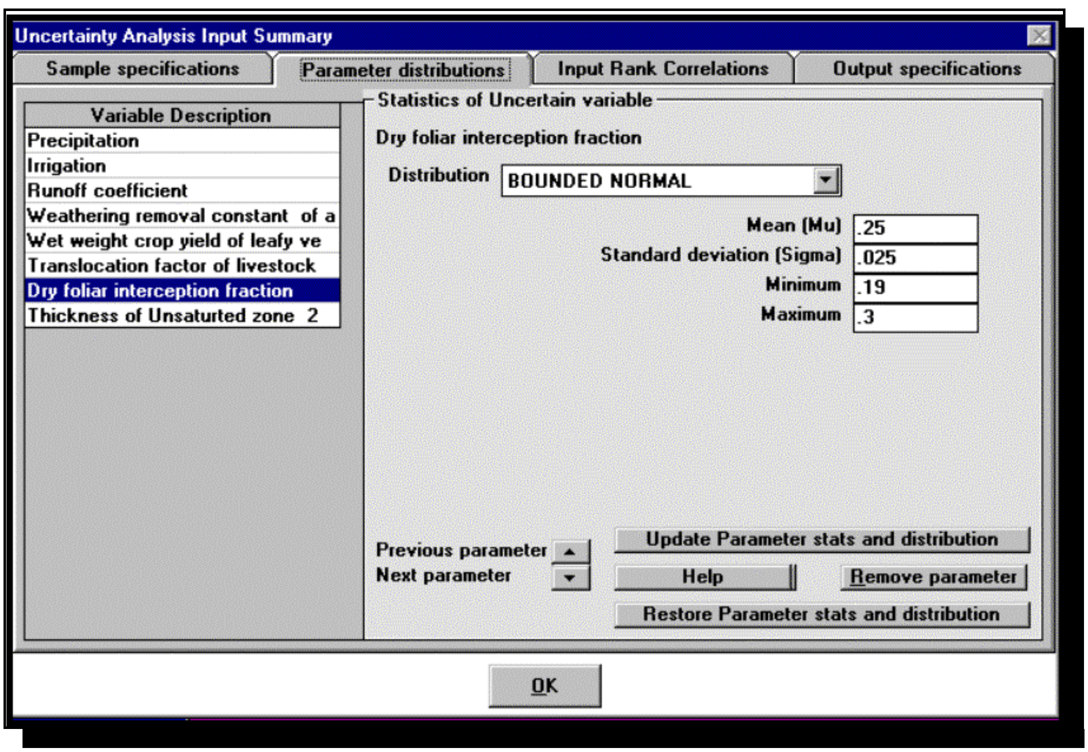

Figure C6.4 Specified Parameter Distributions for Probabilistic Analysis.

Parameter List for Probabilistic Analysis

The list of the currently chosen parameters is shown on the left in a three-column table displaying the variable description, variable name in the code, and the distribution type. If the use clicks on any element in the row, complete distribution properties for the variable will appear for review and edit on the right.

Statistics of Uncertain Variable

The properties involved are the distribution type, shape parameters concerning the specific distribution type, and upper and lower truncation bounds. In this particular example, the shape parameters are for the normal distribution, that is, the mean and standard deviation. If the user wishes to accept the default distribution for this parameter, the “Default for assumptions” can be selected. These assumptions also include those specified on the “Sample Specification” tab that are beyond the input specifications of the deterministic RESRAD codes. The user can also remove the parameter from further probabilistic consideration by clicking the “Remove Parameter” button.

Input Rank Correlations

The input correlations tab screen allows the user to view and edit all correlations between input parameters for probabilistic analysis (Figure C6.5). The paired parameters with non-zero correlations are listed in the left frame. Correlations can be modified, added, or deleted in the right frame.

Navigation

The user can select an existing correlation pair by clicking on its row in the left frame. New pairs are chosen on the right side by selecting the two variables. The edits in this frame are incorporated after clicking the “Update Correlation Table” button. The pair is removed by selecting the “Remove Correlation” button.

Parameter List for Correlation

The currently chosen pairs of parameters are listed in the left frame in a three-column table that shows the variable names in the code and the correlation coefficient. If the user clicks on any element in any row of the table, the correlation can be modified or deleted in the right frame. The range of correlation coefficient is –1.00 to 1.00. The correlation for all pairs not specified here is assumed to be 0.0. The user can check the results of the sampling correlation after the run has been completed. Full descriptions of the variables can be seen in the right frame. If more parameters are chosen for correlation than fit in the window, the left side becomes a scrolling table.

Correlation Edit

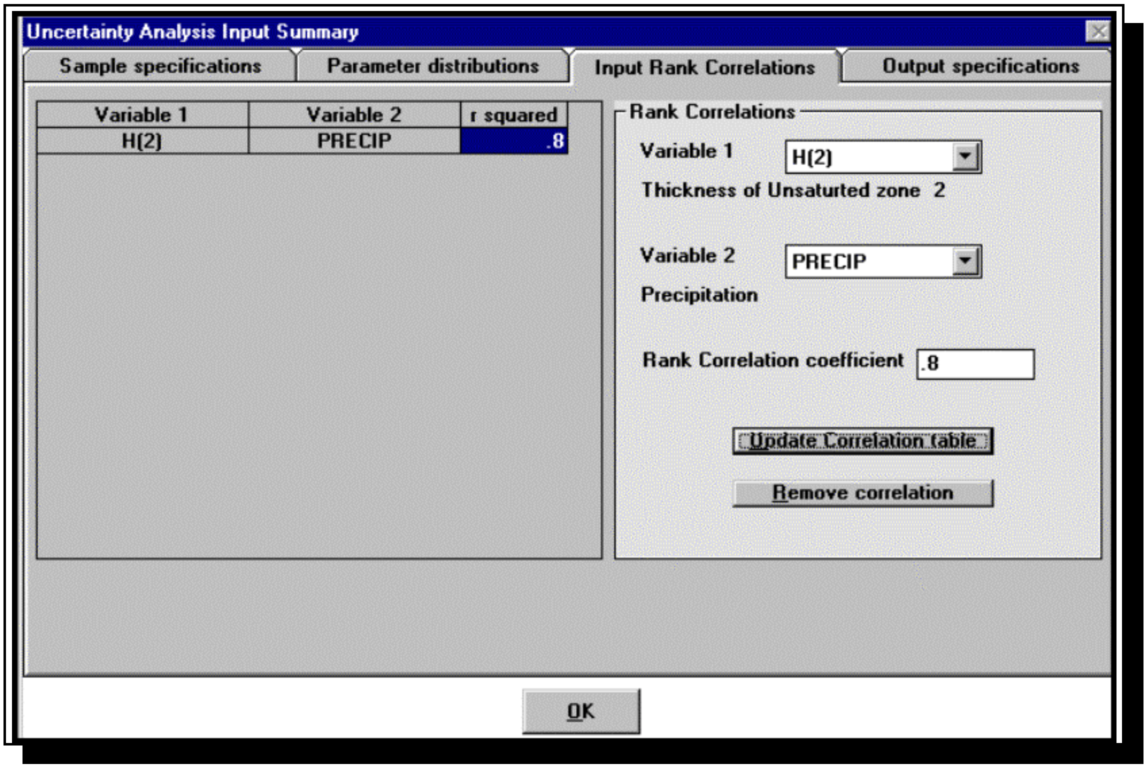

Figure C6.5 Specified Input Rank Correlation for Probabilistic Analysis.

The two parameters in the correlation and the correlation coefficient are shown and editable in the right frame. The user can also remove the parameter from further probabilistic consideration by clicking the "Remove Correlation" button.

6.4 Use of Codes and Models Other Than DandD and RESRAD

Staff should provide flexibility for possible use of other codes and models selected by users. However, less common codes, specifically those developed by users, may require more extensive staff review and verifications. In this context, staff may review the following pertinent aspects when using other less common codes:

1. Scope of code application and applicability to the concerned site;

2. Extensive review of the generic code selection criteria listed in 6.3.1;

3. Review of the mathematical formulation of the associated models and the selected dose conversion factors;

4. Review of the conceptual model, including the source-term model, used in the code, and compatibility with site conditions;

5. Review of code performance and comparison with commonly used and verified codes;

6. Review of code capability regarding handling of default pathways and consistency in selection of default parameters (e.g., occupancy, behavioral, and metabolic parameters); and

7. Detailed review of codes/models documentation and updates for code/model modifications, including QA/QC reviews.

6.5 Modeling of Complex Sites

The term “complex sites” refers to sites with any of the following contamination conditions, or combination of one or more of these conditions:

1. Sites with existing groundwater/surface-water contamination;

2. Sites with diversified and extensive surface/subsurface contamination that may require modeling of multiple sources at the site, with potential impact of one source over another;

3. Sites with current off-site releases such that alternate off-site scenario(s) may be required, or use of on-site resident farmer scenario may be inadequate (e.g., sites with multiple receptors);

4. Sites with physical barriers or vaults; and

5. Sites with unusual physical or lithologic properties, such as highly fractured formation, karst features, or with sinkholes that may significantly impact assumptions of transport models or the overall conceptual model.

Complex sites may require more advanced performance assessment modeling and analysis approaches comparable to the low-level waste performance assessment approaches. Specifically, more advanced approaches may be required to selecting appropriate models/codes, collecting characterization data to support the models selected, source-term assumptions, and approaches to accommodate internal consistencies in the associated complex transport models. Because of the complex nature these sites, staff review will depend on site-specific conditions and the degree of site complexity. Therefore, a generic staff review of complex sites cannot be articulated in the current SRP. Licensees and staff need to interact early for information and directions regarding development of a proper decommissioning plan. In other words, staff may tailor a decommissioning review plan based on actual conditions of the complex site, based on early interaction between NRC staff and the licensee.

7.0 CRITERIA FOR SELECTING OR MODIFYING INPUT PARAMETER VALUES

7.1 Introduction

Any analytical approach to dose assessment will involve the selection of appropriate values for input parameters. Each computer modeling code or other analytical methods that a licensee may use will have its own suite of input parameters. Also, unless the licensee is performing a screening analysis, each site or facility (hereafter referred to collectively as “site”) will likely have its own defining characteristics that must be incorporated into the dose assessment through the selection of input parameter values.

This section provides general guidelines for the staff to consider in evaluating a licensee’s selection of values for input parameters. Three aspects of parameter value selection are addressed:

1. Selection of parameter values or range of values;
2. Technical justification to support value selection; and
3. Evaluation of the impact of parameter selection on dose assessment results.

Section 7.2 addresses several general issues, related to parameter value selection, that a staff should consider. Section 7.3 presents default input parameter data sets for DandD and RESRAD, and discusses the development of data sets for other computer codes and analytical tools. Section 7.4 presents several approaches to modifying the DandD and RESRAD parameter sets for site-specific analyses. (For clarity, all tables are provided at the end of the section.)

7.2 Issues in Modifying Parameters

In addressing the three aspects of parameter value selection identified above, several issues should be discussed. First is the distinction between screening analysis and site-specific analysis, with respect to parameter value modification. Second is the appropriateness of accepting default input parameter values in site-specific analyses. Third is the level of justification expected to support the selection of site-specific input parameter values. The staff should consider these issues in evaluating a licensee’s dose assessment.

7.2.1 Screening Analyses versus Site-Specific Analyses

A licensee may perform a screening analysis to demonstrate compliance with the radiological criteria for license termination specified in Part 20, Subpart E. The screening analysis described in Section 2 of this document requires that the licensee either: (1) refer to radionuclide-specific screening values listed in the *Federal Register* (63 FR 64132 and 64 FR 68395); or (2) use the DandD computer code. A licensee pursuing the screening option may find that implementation of the DandD code is necessary if radionuclides not included in the *Federal Register* listings must be considered.

The staff should ensure that a licensee performing a screening analysis using the DandD code limits parameter modification to identifying radionuclides of interest and specifying the radionuclide concentrations. The staff should verify that the licensee has not modified any other input parameter values. The output file generated by DandD identifies all parameter values that have been modified. Modifying any input parameter value from a default value will constitute a site-specific analysis. The default "screening" input parameter data for DandD are provided for reference in Section 7.3. Modification of the default parameter set for site-specific analysis is discussed in Section 7.4

7.2.2 Default Values Versus Site-Specific Values

DandD and many other computer codes used for dose assessment provide the user with default values for the input parameters. Often, the user only needs to select radionuclides to execute the code. This allows the user to quickly obtain results with very little time expended in developing input data sets.

This has several obvious and significant drawbacks. A typical user of a computer code gains an understanding and appreciation of the conceptual and numerical modeling approaches of a code through the process of developing data input sets. If default parameter values are not available, the user must address each and every input parameter, determine what characteristics of the modeled system the parameter represents and how the parameter is used in the code, and develop a value for the input parameter that is reasonable and appropriate for both the system being modeled and for the conceptual and numerical models implemented by the code. The availability of default values for input parameters could result in the user performing a "site-specific" analysis to modify values for parameters for which site data are readily available and accept the default values as appropriate for the remaining parameters, without an adequate understanding of the parameters and the implications of accepting the default values.

On the other hand, using default values that have been reviewed by the NRC staff and considered appropriate for dose assessments supporting decommissioning: (1) promotes consistency among analyses (where appropriate); (2) focuses licensee and NRC staff resources on parameters considered significant with respect to the dose assessment results; and (3) facilitates review of the licensee's dose assessment by the NRC staff.

To benefit from the advantages while minimizing the disadvantages, the staff should ensure that the licensee employs default parameter values in a manner consistent with the guidance provided in this section.

7.2.3 Justifying Site-Specific Parameter Values

A staff should evaluate whether a licensee submitting a site-specific dose assessment has demonstrated that all parameter input values are appropriate for the site being modeled. However, this does not require the licensee to submit a detailed analysis to support the values selected for each and every input parameter. Instead, the level of justification required should be based on the parameter classification and should be commensurate with the significance of the parameter relative to the dose assessment results, as evaluated through sensitivity analyses. The sensitivity analyses will reflect the relative significance of exposure pathways. Note that the relative significance of exposure pathways may change as parameters are modified. Methods for performing sensitivity analyses are discussed in Section 8.

Dose assessment input parameters may be generally classified as behavioral, metabolic, or physical. Behavioral parameters (B) collectively describe the receptor -- the exposed individual for whom the dose received is being assessed. The values selected for these input parameters will depend on the behavior hypothesized for the exposed individual. Metabolic parameters (M) also describe the exposed individual, but generally address involuntary characteristics of the individual. Physical parameters (P) collectively describe the physical characteristics of the site being modeled. These would include the geohydrological, geochemical, and meteorological characteristics of the site. The characteristics of atmospheric and biospheric transport up to, but not including, uptake by, or exposure of, the dose receptor, would also be considered physical input parameters.

There is always uncertainty associated with the behavior of a hypothetical receptor. For this reason, the licensee may accept a generically defined receptor for its analysis. The generically defined receptor is the “average member of the critical group.” The characteristics of this exposed individual and the criteria for modifying the characteristics for a site-specific analysis are discussed in Section 4. The licensee may use default values for the behavioral and metabolic parameters, with limited justification, if the values are consistent with the generic definition of the average member of the critical group, and the screening group is reflective of the scenario.

The staff should verify that the licensee has used site-specific values for all physical parameters related to geohydrologic conditions. “Site-specific” in this context includes: (1) information directly related to the site; (2) information, characterizing the region, that is consistent with site conditions; and (3) generic information that is consistent with the specific geohydrologic conditions at the site (e.g., consistent with the surface-soil unsaturated-zone soil classifications). The justification for site-specific physical parameter values should demonstrate that the site-specific values selected are not inconsistent with the known or expected characteristics of the physical site being modeled. The level of justification should be based on the significance of the parameter to the results of the dose assessment. The licensee should evaluate the significance through sensitivity analyses (see Section 8). If a licensee relies on the DandD default values for the physical parameters describing geochemical conditions (i.e., partition coefficients) and biosphere transport (e.g., crop yields, soil-to-plant concentration factors), the staff should evaluate whether the default parameters are inconsistent with known or expected conditions at the site.

7.3 Input Parameter Data Sets

7.3.1 DandD Default Probabilistic Parameter Set

Probabilistic analyses using the DandD computer code were performed to establish the screening values for building and surface-soil contamination that were published in the *Federal Register* in November 1998 and December 1999 (63 FR 64132 and 64 FR 68395). In performing these screening analyses, data were compiled for over 600 input parameters and reviewed by the NRC staff. These data are discussed in great detail in NUREG/CR-5512, Volume 3, and are directly incorporated into DandD (starting with Version 2). These data form the reference input parameter set for probabilistic analyses using DandD.

The DandD computer code may be used to evaluate radiological doses for two exposure scenarios: (1) the building occupancy scenario; and (2) the residential scenario. These exposure scenarios and the associated exposure pathways are discussed in detail in Section 4.

Table C7.1 identifies the input parameters required to analyze the DandD building occupancy scenario. Table C7.1 provides the parameter symbol and name, the dimensional units, and a brief description. The fourth column of Table C7.1 indicates whether each parameter is considered to address a behavioral, metabolic or physical characteristic. This parameter classification is defined in NUREG/CR-5512, Volume 3:

1. Behavioral parameters (B) characterize the average member of the critical group -- the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances (10 CFR 20.1003).

2. Metabolic parameters (M) characterize the metabolic functioning of the average member of the critical group. Volumetric breathing rates are the only metabolic parameters used in DandD. (Dose conversion factors, although considered metabolic, are not modified by the DandD user.)

3. Physical parameters (P) describe characteristics of the physical site. The values assigned to the physical parameters depend on the physical characteristics of the site and are generally independent of the characteristics of the average member of the critical group.

Detailed discussion of this classification is provided in NUREG/CR-5512, Volume 3. The fifth column indicates whether the default value assigned to the parameter is a constant value, a derived value (i.e., a function of other input parameters), or a probability distribution function from which a value is sampled with each calculational iteration of the code. For constant parameters, the default value is provided. For parameters characterized by a distribution, the values defining the distribution are provided. The DandD distribution types and distribution parameters are provided in Table C7.2.

For the residential scenario, DandD requires values for over 250 general input parameters and over 300 element-specific parameters. The general input parameters are identified in Table C7.3. For each parameter associated with the residential scenario, the information presented in Table C7.3 is the same as that described in the preceding paragraph for Table C7.1. Information is not provided here for the element-specific parameters:

1. Partition coefficients
2. Soil-to-plant transfer factors - leafy
3. Soil-to-plant transfer factors - root
4. Soil-to-plant transfer factors - fruit
5. Soil-to-plant transfer factors - grain
6. Animal transfer factor - beef
7. Animal transfer factor - poultry
8. Animal transfer factor - milk
9. Animal transfer factor - eggs
10. Bioaccumulation factor - fish

Instead, the reader is referred to NUREG/CR-5512, Volume 3, and the current version of the DandD computer code.

7.3.2 DandD Default Deterministic Parameter Set

Several default parameter sets have been developed to support deterministic analyses with the DandD code. NUREG/CR-5512, Volume 1, initially presented the conceptual and mathematical foundation of the DandD code, and deterministic values for many input parameters were presented in the document. Volume 3 of NUREG/CR-5512 incorporated much of the parameter information from Volume 1 in developing the default probabilistic input parameter set, making corrections and updating values as necessary. Therefore, a licensee should not refer to NUREG/CR-5512, Volume 1, as a primary source for a default deterministic parameter set.

Similarly, DandD Version 1, which did not support probabilistic analyses, provided a default deterministic input parameter set. DandD Version 2 has replaced Version 1, the DandD Version 1 default parameter set should not be used as a reference data set.

A user may perform deterministic analyses using DandD (Version 2 or later). This would require the user to change all parameter distribution types to “constant” and specify a single value. However, the NRC does not intend to provide a default deterministic input parameter set to be used in conjunction with DandD. Also, a licensee intending to support decommissioning activities with deterministic dose assessments should ensure that the deterministic approach will provide the information necessary to demonstrate compliance (e.g., support necessary sensitivity analyses as described in Section 8).

7.3.3 RESRAD Default Probabilistic Parameter Set

The most recent versions of the RESRAD and RESRAD-BUILD computer codes include the option to perform probabilistic dose assessments. The RESRAD team at Argonne National Laboratory worked with NRC staff to develop a default input parameter set that may be used to perform probabilistic dose assessments with the RESRAD and RESRAD-BUILD codes. These default probabilistic input parameter sets are documented in *Parameter Distributions for Use in RESRAD and RESRAD-BUILD Computer Codes* (Biwer, *et al.*, 2000).

Table C7.4 identifies the default probabilistic parameter set for the RESRAD-BUILD code. The table identifies each RESRAD-BUILD input parameter and associated dimensional units, and provides the parameter classification (B, M or P). If two classification codes are provided, the first is considered the primary classification. Table C7.4 then provides the default parameter distribution type, and the values for the distribution’s statistical parameters.

Table C7.5 identifies the type of parameter distributions available in the RESRAD and RESRAD-BUILD codes to characterize the RESRAD and RESRAD-BUILD input parameters. Table C7.5 also identifies the input variable necessary to define each distribution type. The parameter distributions are discussed in detail in Appendix A of Biwer, *et al.* (2000).

Table C7.6 identifies the default probabilistic parameter set for the RESRAD code. For each RESRAD input parameter, Table C7.6 provides the same information as that provided for RESRAD-BUILD, as described in the preceding paragraph.

Table C7.6 does not provide the default parameter distributions for the element-specific parameters required by RESRAD:

1. Distribution coefficients for the contaminated zone
2. Distribution coefficients for the unsaturated zone
3. Distribution coefficients for the saturated zone
4. Transfer factors for plants
5. Transfer factors for milk
6. Transfer factors for meat
7. Bioaccumulation factors for fish

This information is provided in Biwer, *et al.* (2000). Also, Tables C7.4 and C7.6 do not provide the default values for parameters for which probabilistic parameters were not developed through Biwer, *et al.* (2000). All RESRAD and RESRAD-BUILD parameters were evaluated and a subset was identified for probabilistic evaluation, as documented in *Selection of RESRAD and RESRAD-BUILD Input Parameters for Detailed Distribution Analysis* (Cheng, *et al.*, 1999).

7.3.4 RESRAD Default Deterministic Parameter Set

Versions of RESRAD (e.g., Versions 5.82, 5.91 and 5.95) and RESRAD-BUILD (Version 2.37) include default parameter values that support the RESRAD and RESRAD-BUILD deterministic analyses. Many of these default parameters are documented in *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, *et al.*, 1993a). As a set, these are not considered to be acceptable default input parameter values for performing dose assessments in support of decommissioning. Instead, a licensee may use the parameter set described in the preceding section as a starting point for its analyses. The staff should ensure that a licensee justifies the selected values and that the values are consistent with existing or expected conditions at the site.

7.3.5 Input Data Sets for Other Computer Codes

A licensee may choose to use a computer code or analytical approach other than DandD or RESRAD/RESRAD-BUILD to perform the dose assessment in support of decommissioning (see Section 6). Each code or analytical approach will have a unique set of input parameters. However, there will likely be some input parameters that are also included in the DandD input parameter set.

The staff should verify that a licensee provides a listing of all input parameters required in its analysis. For each parameter, the licensee should provide a discussion similar to that provided in NUREG/CR-5512, Volume 3, Chapters 5 and 6. The discussion should include the parameter name, a description of the parameter, a discussion of how the parameter is used in the dose assessment model, and the licensee's classification of the input parameter (i.e., behavioral, metabolic or physical). For the parameters being represented by constant values, the licensee should provide the range of appropriate values for the parameter, the single value selected for the parameter, and the basis for the range and selected value, including references. The level of justification to be provided in the basis will be based on the classification of the parameter (i.e., behavioral, metabolic or physical) and the relative significance of the parameter in the dose assessment.

For input parameters classified as “behavioral” or “metabolic,” the staff should verify that the licensee specifies values that are consistent with the default screening values specified for the DandD behavioral and metabolic parameters (Tables C7.1 and C7.3), as long as the definition of the critical group has not been modified (see Section 4). Consistency will depend on the conceptual and numerical models underlying the code being used and the manner in which the parameters are used in the models. Using consistent behavioral and metabolic parameter values for the default critical group will support a relatively standardized definition of the “average member of the critical group” among analyses. The basis the licensee provides for these parameters should identify the comparable DandD parameters and discuss any adjustments necessary to accommodate differences between DandD and the code or analytical method being used.

For the input parameters the licensee classifies as physical, other than those related to geochemical conditions and atmospheric and biospheric transport, the staff should verify that the licensee uses site-specific values whenever available. The licensee should provide the soil classification for all soil units and specify consistent values for all geohydrologic parameters. For geochemical parameters, such as partition coefficients, the licensee may rely on DandD default probabilistic values, as long as justification is provided to demonstrate that the values are not inconsistent with geochemical conditions at the site. Site conditions may require that the licensee modify the default parameters to ensure consistency. Additionally, it is important to note that the distributions may not be applicable to codes other than DandD. For meteorological parameters, the licensee should use values that are based on applicable site or regional data. For physical parameters related to atmospheric and biospheric transport, the licensee may accept DandD default values with minimal justification, using NUREG/CR-5512, Volume 3, as a starting reference point. Physical parameters related to biosphere transport would include parameters such as crop yields, animal ingestion rates, transfer factors, and crop growing times. The staff should evaluate whether the justification provided by the licensee demonstrates that the default values are not inconsistent with conditions at the site.

7.4 Recommended Approach to Parameter Modification

Any analysis that does not meet the conditions of a screening analysis will be considered a site-specific analysis. This will include all analyses using the DandD computer code where one or more input parameters values have been modified from default values, as well as analyses using analytical methods or computer codes other than DandD.

7.4.1 Modifying the DandD Default Probabilistic Parameter Set

A staff should expect that a licensee who is modifying parameter values for a site-specific analysis using DandD is cognizant of the following:

1. What the parameter represents
2. How the parameter is used in the DandD code

3. The basis for the default parameter value
4. Which parameters are physically or numerically correlated

Tables C7.1 and C7.3 identify the DandD input parameters and default distribution types and values. NUREG/CR-5512, Volumes 1 through 3, describes in detail what each parameter is intended to represent. Volume 1 provides the original parameter definitions. Volume 1 also provides the mathematical formulations, underlying the DandD code, that will allow the user to: (1) understand how each parameter is used and the implication of parameter modification on the resulting calculated dose; and (2) identify numerical correlations among parameters. Volume 2 (the DandD user's manual) redefines several of the input parameters and mathematical formulations based on implementation of the Volume 1 methodology in the DandD computer code. Finally, Volume 3 provides a detailed discussion of most input parameters, allowing the user to fully understand the basis for the default values. Volume 3 provides a parameter description and a discussion of how parameters are used in the code, a review of the information sources on which the default values are based, a discussion of uncertainty in the default parameter values, and insight into the selection of alternative parameter values. The DandD user performing site-specific analyses with DandD should be cognizant of the information provided in the three volumes of NUREG/CR-5512.

A licensee may modify DandD behavioral (B) and metabolic (M) input parameter values for the building occupancy and residential scenarios to reflect the characteristics of the average member of a *site-specific* critical group. NUREG/CR-5512, Volume 3, provides the basis for the default value for each behavioral and metabolic parameter. If the licensee modifies the values for these parameters, the staff should verify that the licensee has defined a *site-specific* critical group, as discussed in Section 4 of this appendix. The licensee may provide site-specific parameter distributions that reflect the variability of the behavior of the average member of the site-specific critical group, or the licensee may use the mean of the site-specific information as a constant-value input for these parameters, consistent with the concept of the "average member" of the critical group. The justification required to support modification of behavioral and metabolic parameter values should be consistent with the information presented in Section 4.

For the DandD building occupancy scenario, there are only three physical parameters: the resuspension factor (Rfo*), which is derived from the loose fraction (Fl) and the loose resuspension factor (Rfo). Default values for these parameters are given in Table C7.1. Unless the licensee has site-specific information to indicate that the default values are inconsistent with the default values, the staff should verify that the licensee has used the default values for these physical parameters in its calculations.

There are many more physical parameters for the DandD residential scenario (Table C7.3). The physical parameters may be considered in several groups. The following physical parameters address the geohydrologic conditions:

Unsaturated Zone Thickness (H2)	CONTINUOUS LINEAR
Soil Classification (SCSST)	DISCRETE CUMULATIVE
Porosity Probability (NDEV)	UNIFORM (0 to 1)
Permeability Probability (KSDEV)	UNIFORM (0 to 1)

Parameter "b" Probability (BDEV)	UNIFORM (0 to 1)
Water Application Rate (AP)	CONTINUOUS LINEAR
Surface Soil Porosity (N1)	DERIVED
Unsaturated Zone Porosity (N2)	DERIVED
Surface Soil Saturation (F1)	DERIVED
Unsaturated Zone Saturation (F2)	DERIVED
Infiltration Rate (INFIL)	DERIVED
Surface Soil Density (RHO1)	DERIVED
Unsaturated Zone Density (RHO2)	DERIVED
Surface Soil Permeability (Ksat1)	DERIVED
Soil Moisture Content (sh)	DERIVED

For these physical parameters, the licensee should use site-specific distributions and values. [As stated previously, “site-specific” in this context includes: (1) information directly related to the site; (2) information characterizing the region that is consistent with site conditions; and (3) generic information that is consistent with the specific geohydrologic conditions at the site (e.g., consistent with the unsaturated zone soil classification)].

The staff should verify that the licensee has provided site-specific information for the thickness of the unsaturated zone and the soil classification. In addition, the licensee should ensure that the water application rate is consistent with the irrigation rate (behavioral parameter) if the licensee modifies the irrigation rate. Alternatively, the licensee may demonstrate, through sensitivity analyses, that the dose assessment results are insensitive to these parameters, and use the default values.

Values for the derived parameters will be generated internally according to the soil classification indicated and the uniform distributions defined for the porosity probability (NDEV), the permeability probability (KSDEV), and the parameter "b" probability (BDEV). The staff should verify that the licensee has not modified the uniform distributions for these three parameters. If site-specific data are available, the licensee may proceed to modify the derived geohydrologic parameters, consistent with the information presented in NUREG/CR-5512, Volume 3.

The only geochemical parameter used in DandD is the element-specific partition coefficient. As documented in NUREG/CR-5512, Volume 3, the partition coefficients at a site are generally dependent on geochemical conditions and are generally independent of soil classification. If the licensee has used the default distributions, the staff should evaluate whether the defaults are inconsistent with known or expected conditions at the site.

The following physical parameters address radionuclide transport through the atmosphere and exposure to direct radiation:

Outdoor Shielding Factor (SFO)	CONSTANT
Flood dust loading (PD)	UNIFORM
Indoor Resuspension Factor (RFR)	LOGUNIFORM
Outdoor Dust Loading (CDO)	LOGUNIFORM
Indoor Dust Loading (CDI)	DERIVED
Indoor/Outdoor Penetration Factor (PF)	UNIFORM
Gardening Dust Loading (CDG)	UNIFORM

The remaining physical parameters address characteristics of transport through the biosphere:

Growing Periods (produce, forage, grain, hay) [TG_(#)]	CONSTANT
Animal Product Specific Activity (SATac)	CONSTANT
Livestock Feeding Periods [TF_(#)]	CONSTANT
Animal Product Yields [YA(#)]	CONSTANT
Interception Fractions [R_(#)]	UNIFORM
Translocation factors [T_(#)]	CONSTANT
Contaminated Fractions [x_(#)]	CONSTANT
Crop Yields [Y_(#)]	CONTINUOUS LINEAR
Wet-to-dry conversion factors [W_(#)]	CONTINUOUS LINEAR
Animal Ingestion Rates [Q_(#)]	BETA
Mass-Loading factors [ML_(#)]	CONSTANT
Carbon Fractions [fc_(#)]	CONSTANT
Hydrogen Fractions [fh_(#)]	CONSTANT
Hydrogen Fraction: Soil (fhd016)	DERIVED
Tritium Equivalence: Plant/Soil (sasvh)	CONSTANT
Tritium Equivalence: Plant/Water (sawvh)	CONSTANT
Tritium Equivalence: Animal Products (satah)	CONSTANT

These two groups of physical parameters describe characteristics of the transport of radionuclides through the atmosphere or biosphere up to the point of ingestion or inhalation by, or external exposure to, the receptor. The licensee may accept the default values for these parameters as long as the default values are not inconsistent with conditions that may exist at the site in the future. The licensee should review the basis given in NUREG/CR-5512, Volume 3, for the default values, to determine whether the basis is inconsistent with conditions hypothesized for the site. If so, the licensee must modify the input values accordingly. The staff should ensure that the licensee documents this assessment for each of the physical parameters. Note that modifying several of these parameters (e.g., crop yields, animal product yields) will affect the derived behavioral parameters (e.g., area of land cultivated).

For the physical parameters, the licensee may use representative distributions or values. A representative distribution should take into account spatial and temporal variation of the parameter at the site. A representative distribution, for example, would be a precipitation rate based on the historical precipitation data for the site, if available, or from surrounding defensibly relevant monitoring locations. The arithmetic or geometric mean value is often used in defining a representative distribution. However, the calculation of a mean value should be weighted to account for non-uniform sampling or other non-uniform parameters (e.g., material volume). The licensee is not required to routinely adopt worst-case, bounding, upper- or lower-percentile, or other overly conservative values in defining distributions.

The review of this information will be facilitated if the licensee presents the information in a tabular or list format. The staff should verify that the licensee has listed every DandD input parameter with the default screening distributions or value. For those parameters for which the licensee is using site-specific values (e.g., the physical parameters), the licensee should provide the range of plausible values for the site, the selected value, and supporting justification, including references.

7.4.2 Modifying the RESRAD Default Probabilistic Parameter Set

A licensee using the RESRAD or RESRAD-BUILD codes may change parameters from the default values to reflect a site-specific critical group or site-specific conditions, or to incorporate site-specific data. As discussed in the preceding section, the staff should expect that a licensee who is modifying parameter values for a site-specific analysis using RESRAD or RESRAD-BUILD is cognizant of the following:

1. What the parameter represents
2. How the parameter is used in the code
3. The basis for the default parameter value
4. Which parameters are physically or numerically correlated

Tables C7.4 and Table C7.6 identify the RESRAD and RESRAD-BUILD input parameters and default distribution types and values. The licensee should refer to the current code documentation to determine how the parameters are used in the code. References to the documentation should be provided. With respect to the basis for the default parameter distributions and values, the licensee should refer to Biwer, *et al.* (2000).

When modifying parameter distributions and values, the licensee should consider whether the parameters are classified as behavioral, metabolic or physical. For behavioral and metabolic parameters for which probability distributions have been developed, the licensee may adopt the default distribution, or the mean of the default distribution, as long as the licensee has not modified the definition of the critical group. For behavioral and metabolic parameters for which distributions have not been developed, the licensee should use values or distributions that are consistent with the DandD default distributions, as applicable.

A licensee may modify behavioral (B) and metabolic (M) default input parameter values to reflect the characteristics of the average member of a *site-specific* critical group. The licensee may modify the values for these parameters if the licensee has defined a *site-specific* critical group, as discussed in Section 4 of this appendix. The licensee may provide site-specific parameter distributions that reflect the variability of the behavior of the average member of the site-specific critical group, or the licensee may use the mean of the site-specific information as a constant-value input for these parameters, consistent with the concept of the "average member" of the critical group. The justification required to support modification of behavioral and metabolic parameter values should be consistent with the information presented in Section 4.

For the physical parameters, the licensee should use site-specific information for the physical parameters addressing geohydrologic and meteorologic conditions. The level of justification for the parameter values should be based on sensitivity analyses. Alternatively, sensitivity analyses may be used to support the use of default parameters.

For the physical parameters describing geochemical conditions (i.e., distribution coefficients), the licensee should use values that are consistent with the DandD default values, as long as the values are not inconsistent with known or expected site conditions. Justification supporting the values should be based on sensitivity analyses.

For the remaining physical parameters (atmospheric and biospheric transport), the licensee may use values that are consistent with the DandD default values, as applicable, as long as the default values are not inconsistent with known or expected site conditions.

7.4.3 Sensitivity Analyses

The level of justification required to support site-specific parameter values should be commensurate with the sensitivity of the results of the dose assessment to the selected values. Sensitivity analyses are discussed in detail in Section 8.

Table C7.1 Default parameter distributions and values for the DandD building occupancy scenario

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
To:Time In Building	(hr/week)	The time in the building during the occupancy period	Behavioral	CONTINUOUS LINEAR	Value	Probability
					35	0
					39	0.1
					40	0.1001
					40.01	0.581
					41	0.5811
					48	0.739
					49	0.7391
					59	0.892
					60	0.8921
					65	1
Tto:Occupancy Period	(days)	The duration of the occupancy exposure period	Behavioral	CONSTANT	Value	365.25
Vo:Breathing Rate	(m**3/hr)	The average volumetric breathing rate during building occupancy for an 8-hour work day	Metabolic	CONTINUOUS LINEAR	Value	Probability
					0.68	0
					0.681	0.14
					1.18	0.29
					1.33	0.34
					1.331	0.53
					1.37	0.54
					1.371	0.57
					1.9	0.78
					1.901	0.84
					3.04	1
RFo*:Resuspension Factor	(1/m)	The resuspension factor during the occupancy period	Physical	DERIVED		
GO*:Ingestion Rate	(m2/hr)	The secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy	Behavioral	DERIVED		
Tstart:Start Time	(days)	The start time of the scenario in days	Program	CONSTANT	Value	0
Tend:End Time	(days)	The ending time of the scenario in days	Program	CONSTANT	Value	365.25
dt:Time Step Size	(days)	The time step size	Program	CONSTANT	Value	365.25
Pstep:Print Step Size	(none)	The time steps for the history file. Doses will be written to the history file every n time steps.	Program	CONSTANT	Value	1
AOExt:External Exposure Area	(m**2)	Minimum surface area to which occupant is exposed via external radiation during occupancy period	Behavioral	CONSTANT	Value	100
AOInh:Inhalation Exposure Area	(m**2)	Minimum surface area to which occupant is exposed via inhalation during occupancy period	Behavioral	CONSTANT	Value	100
AOIng:Secondary Ingestion Exposure Area	(m**2)	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	Behavioral	CONSTANT	Value	100
AO:Exposure Area	(m**2)	Minimum surface area to which occupant is exposed during the occupancy period	Behavioral	DERIVED		
Fl:Loose Fraction	(none)	Fraction of surface contamination available for resuspension and ingestion	Physical	CONSTANT	Value	0.1
Rfo:Loose Resuspension Factor	(1/m)	Resuspension factor for loose contamination	Physical	CONTINUOUS LOGARITHMIC	Value	Probability
					0.00000912	0
					0.00011	0.767
					0.000146	0.909
					0.000162	0.95
					0.000185	0.99
					0.00019	1
GO:Loose Ingestion Rate	(m2/hr)	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	Behavioral	LOGUNIFORM	Lower Limit	0.0000275
					Upper Limit	0

Table C7.2 DandD Distribution Types and Distribution Parameters

Distribution Type	Distribution Parameters			
Fixed	Value			
Normal	Mean	Standard Deviation		
Truncated Normal	Mean	Standard Deviation	Lower	Upper
Bounded Normal	Mean	Standard Deviation	Lower Bound	Upper Bound
Normal-B	Value at 0.001	Value at 0.999		
Lognormal	Mean	Error Factor		
Lognormal-N	Mean	Standard Deviation		
Truncated Lognormal	Mean	Error Factor	Lower	Upper
Truncated Lognormal-N	Mean	Standard Deviation	Lower	Upper
Bounded Lognormal	Mean	Error Factor	Lower Bound	Upper Bound
Bounded Lognormal-N	Mean	Standard Deviation	Lower Bound	Upper Bound
Lognormal-B	Value at 0.001	Value at 0.999		
Uniform	A	B		
Loguniform	A	B		
Continuous Linear	Table of (Value, Probability) pairs			
Continuous Logarithmic	Table of (Value, Probability) pairs			
Continuous Frequency	Table of (Value, Probability) pairs			
Exponential	lambda			
Maximum Entropy	A	mu	B	
Weibull	alpha	beta		
Pareto	alpha	beta		
Gamma	alpha	beta		
Beta	A	B	p	q
Inverse Gaussian	mu	lambda		
Triangular	a	b	c	
Poisson	lambda			
Binomial	p	n		
Negative Binomial	p	n		
Geometric	p			
Hypergeometric	N_N	N_1	N_R	
Discrete Cumulative	Table of (Value, Probability) pairs			
Discrete Histogram	Table of (Value, Probability) pairs			

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
Nunsat:Number of Unsaturated Layers	(none)	Number of model layers used to represent the unsaturated zone	Program	CONSTANT	Value	10
TstartR:Start Time	(days)	The start time of the scenario in days	Program	CONSTANT	Value	0
TendR:End Time	(days)	The ending time of the scenario in days	Program	CONSTANT	Value	365250
dtR:Time Step Size	(days)	The time step size	Program	CONSTANT	Value	365.25
PstepR:Print Step Size	(none)	The time steps for the history file. Doses will be written to the file every n time steps	Program	CONSTANT	Value	1
TI:Indoor Exposure Period	(days/year)	The time the resident spends indoors	Behavioral	CONTINUOUS LINEAR	Value	Probability
					174	0
					174.1235103	0.001
					190.2001539	0.011
					201.5678204	0.051
					208.2074862	0.101
					218.3988701	0.201
					226.267133	0.301
					232.067675	0.401
					238.4925874	0.501
					243.9088559	0.601
					249.0237087	0.701
					255.3119694	0.801
					266.283124	0.901
					273.1742586	0.951
					279.6832122	0.981
					297.9681388	0.999
					300	1
TX:Outdoor Exposure Period	(days/year)	The time the resident spends outdoors	Behavioral	CONTINUOUS LINEAR	Value	Probability
					16.8	0
					16.81022084	0.001
					21.10823623	0.011
					24.7609128	0.051
					27.86683935	0.101
					32.48008262	0.201
					35.37298712	0.301
					38.32151724	0.401
					40.87678657	0.501
					44.32710521	0.601
					48.01356933	0.701
					52.2774518	0.801
					58.04958505	0.901
					63.3583675	0.951
					69.87385897	0.981
					84.31919736	0.999
					90	1
TG:Gardening Period	(days/year)	The time the resident spends gardening	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0.02	0
					0.035026723	0.001
					0.094861902	0.011
					0.324865515	0.051
					0.450366921	0.101
					0.720182691	0.201
					1.03122036	0.301

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					1.346901703	0.401
					1.742765998	0.501
					2.564120244	0.601
					3.579223911	0.701
					5.206812576	0.801
					7.072859506	0.901
					8.440970062	0.951
					10.99361891	0.981
					16.68630202	0.999
					17	1
TTR:Total time in period	(days/year)	Total time in the 1-year exposure period	Behavioral	CONSTANT	Value	365.25
SFI:Indoor Shielding Factor	(none)	Shielding factor for the residence	Behavioral	DISCRETE CUMULATIVE	Value	Probability
					0.479	0.25
					0.486	0.5
					0.517	0.75
					0.857	1
SFO:Outdoor Shielding Factor	(none)	Shielding factor for the cover soil	Physical	CONSTANT	Value	1
PD:Flood dust loading	(g/m**2)	Floor dust loading	Physical	UNIFORM	Lower Limit	0.02
					Upper Limit	0.3
RFR:Indoor Resuspension Factor	(1/m)	Resuspension factor for indoor dust	Physical	LOGUNIFORM	Lower Limit	0.0000001
					Upper Limit	0.00008
CDO:Outdoor Dust Loading	(g/m**3)	Average dust loading outdoors	Physical	LOGUNIFORM	Lower Limit	0.0000001
					Upper Limit	0.0001
CDI:Indoor Dust Loading	(g/m**3)	Average dust loading indoors	Physical	DERIVED		
PF:Indoor/Outdoor Penetration Factor	(none)	Fraction of outdoor dust in indoor air	Physical	UNIFORM	Lower Limit	0.2
					Upper Limit	0.7
CDG:Gardening Dust Loading	(g/m**3)	Average dust loading while gardening	Physical	UNIFORM	Lower Limit	0.0001
					Upper Limit	0.0007
VR:Indoor Breathing Rate	(m**3/hr)	Breathing rate while indoors	Metabolic	CONSTANT	Value	0.9
VX:Outdoor Breathing Rate	(m**3/hr)	Breathing rate while outdoors	Metabolic	CONSTANT	Value	1.4
VG:Gardening Breathing Rate	(m**3/hr)	Breathing rate while gardening	Metabolic	CONSTANT	Value	1.7
GR:Soil Ingestion Transfer Rate	(g/d)	Average rate of soil ingestion	Behavioral	TRIANGULAR	Lower Limit	0
					Mode	0.05
					Upper Limit	0.1
H1:Surface Soil Thickness	(m)	Thickness of the surface soil layer	Physical	CONSTANT	Value	0.15
H2:Unsaturated Zone Thickness	(m)	Thickness of the unsaturated zone	Physical	CONTINUOUS LINEAR	Value	Probability
					0.304785126	0
					0.667479427	4.76E-03
					0.810728436	9.52E-03
					0.920451082	1.43E-02
					0.993599512	0.019047619
					1.030173728	2.38E-02
					1.069795794	2.86E-02
					1.139896373	3.33E-02
					1.209996952	3.81E-02
					1.298384639	4.29E-02
					1.307528193	4.76E-02
					1.322767449	5.24E-02
					1.563547699	5.71E-02
					1.575739104	6.19E-02
					1.612313319	6.67E-02
					1.685461749	7.62E-02
					1.78299299	8.57E-02
					1.804327949	9.05E-02
					1.813471503	9.52E-02

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					1.840902164	0.1
					1.865284974	0.104761905
					1.923194148	0.10952381
					2.042060347	0.114285714
					2.099969521	0.119047619
					2.109113075	0.123809524
					2.322462664	0.128571429
					2.359036879	0.133333333
					2.368180433	0.138095238
					2.389515392	0.142857143
					2.435233161	0.147619048
					2.438281012	0.152380952
					2.447424566	0.157142857
					2.590673575	0.161904762
					2.630295642	0.166666667
					2.694300518	0.171428571
					2.785736056	0.176190476
					2.807071015	0.180952381
					2.898506553	0.185714286
					2.953367876	0.19047619
					3.069186224	0.195238095
					3.175861018	0.2
					3.221578787	0.204761905
					3.294727217	0.20952381
					3.337397135	0.214285714
					3.37397135	0.219047619
					3.444071929	0.223809524
					3.581225236	0.228571429
					3.6147516	0.233333333
					3.660469369	0.238095238
					3.736665651	0.242857143
					3.85553185	0.247619048
					3.882962511	0.252380952
					4.172508382	0.257142857
					4.254800366	0.261904762
					4.440719293	0.271428571
					4.632733923	0.276190476
					4.873514173	0.280952381
					5.13258153	0.285714286
					5.18134715	0.29047619
					5.544041451	0.295238095
					5.83053947	0.3
					5.85492228	0.304761905
					5.864065834	0.30952381
					5.900640049	0.314285714
					6.062176166	0.319047619
					6.132276745	0.323809524
					6.16885096	0.328571429
					6.21761658	0.333333333
					6.31209997	0.338095238
					6.36086559	0.342857143
					6.397439805	0.347619048
					6.455348979	0.352380952
					6.50716245	0.357142857
					6.549832368	0.361904762

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					6.598597988	0.366666667
					6.857665346	0.371428571
					6.924718074	0.376190476
					6.949100884	0.385714286
					6.973483694	0.39047619
					7.086254191	0.395238095
					7.18073758	0.4
					7.345321548	0.404761905
					7.363608656	0.40952381
					7.39713502	0.414285714
					7.430661384	0.419047619
					7.458092045	0.423809524
					7.589149649	0.428571429
					7.601341055	0.433333333
					7.640963121	0.438095238
					7.869551966	0.442857143
					8.098140811	0.447619048
					8.277964035	0.452380952
					8.345016763	0.457142857
					8.704663212	0.461904762
					8.710758915	0.466666667
					8.729046023	0.471428571
					8.790003048	0.476190476
					8.802194453	0.480952381
					8.817433709	0.485714286
					8.850960073	0.49047619
					8.887534288	0.495238095
					8.896677842	0.5
					8.98811338	0.504761905
					8.997256934	0.50952381
					9.13136239	0.514285714
					9.143553795	0.519047619
					9.20451082	0.523809524
					9.305089912	0.528571429
					9.545870162	0.533333333
					9.594635782	0.538095238
					9.631209997	0.542857143
					9.859798842	0.547619048
					10.47241695	0.552380952
					10.7131972	0.557142857
					11.31057604	0.561904762
					11.54221274	0.566666667
					11.67022249	0.571428571
					11.96586407	0.576190476
					12.56933862	0.580952381
					12.63334349	0.585714286
					12.78878391	0.59047619
					13.15452606	0.595238095
					13.23681804	0.6
					13.35263639	0.604761905
					13.36787565	0.60952381
					13.62389515	0.614285714
					13.67875648	0.619047619
					13.75495276	0.623809524
					14.0902164	0.628571429

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					14.48948491	0.633333333
					15.05028955	0.638095238
					15.22706492	0.642857143
					16.08046327	0.647619048
					16.22066443	0.652380952
					16.48582749	0.657142857
					16.55897592	0.661904762
					16.85156964	0.666666667
					17.38494361	0.671428571
					18.16519354	0.676190476
					18.42121304	0.680952381
					18.42730875	0.685714286
					18.65589759	0.69047619
					19.44833892	0.695238095
					20.05486132	0.7
					20.67967083	0.704761905
					20.75891496	0.70952381
					21.6885096	0.714285714
					22.37427614	0.719047619
					22.72782688	0.723809524
					22.85888449	0.728571429
					22.94422432	0.733333333
					24.01402012	0.738095238
					24.65711673	0.742857143
					25.96159707	0.747619048
					26.47058824	0.752380952
					27.2173118	0.757142857
					27.30265163	0.761904762
					27.57086254	0.766666667
					27.73239866	0.771428571
					27.78116428	0.776190476
					27.98537031	0.780952381
					28.59798842	0.785714286
					29.44224322	0.79047619
					30.05790917	0.795238095
					30.33831149	0.8
					30.34135934	0.804761905
					30.54556538	0.80952381
					30.74977141	0.814285714
					31.11551356	0.819047619
					31.69155745	0.823809524
					31.69765315	0.828571429
					31.74337092	0.833333333
					32.22797927	0.838095238
					33.87077111	0.842857143
					34.82474855	0.847619048
					35.43736666	0.852380952
					36.04388906	0.857142857
					36.77232551	0.861904762
					40.30478513	0.866666667
					40.7192929	0.871428571
					42.36513258	0.876190476
					42.87717159	0.880952381
					44.17860408	0.885714286
					47.16549832	0.89047619

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					49.65864066	0.895238095
					51.15208778	0.9
					61.31057604	0.904761905
					61.89881134	0.90952381
					62.27674489	0.914285714
					63.15147821	0.919047619
					65.86711368	0.923809524
					67.32703444	0.928571429
					74.66930814	0.933333333
					79.24413289	0.938095238
					81.17342274	0.942857143
					82.81316672	0.947619048
					84.72416946	0.952380952
					89.57634867	0.957142857
					94.67845169	0.961904762
					107.5952454	0.966666667
					113.1331911	0.971428571
					114.7820786	0.976190476
					141.7098446	0.980952381
					176.9094788	0.985714286
					177.9945139	0.99047619
					180.2499238	0.995238095
					315.8488266	1
N1:Surface Soil Porosity	(none)	Porosity of the surface soil layer	Physical	DERIVED		
N2:Unsaturated Zone Porosity	(none)	Porosity of the unsaturated zone	Physical	DERIVED		
F1:Surface Soil Saturation	(none)	Saturation ratio of the surface soil layer	Physical	DERIVED		
F2:Unsaturated Zone Saturation	(none)	Saturation ratio of the unsaturated zone	Physical	DERIVED		
INFIL:Infiltration Rate	(m/y)	Net rate of infiltration to aquifer	Physical	DERIVED		
SCSST:Soil Classification	(none)	SCS soil classification ID	Physical	DISCRETE CUMULATIVE	Value	Probability
					1	0.0001
					2	0.0013425
					3	0.0105775
					4	0.0251375
					5	0.06169
					6	0.108945
					7	0.1616875
					8	0.2120025
					9	0.285065
					10	0.50956
					11	0.7583675
					12	1
NDEV:Porosity Probability	(none)	Relative porosity value within the distribution for this soil type	Physical	UNIFORM	Lower Limit	0
					Upper Limit	1
KSDEV:Permeability Probability	(none)	Relative permeability value within the distribution for this soil type	Physical	UNIFORM	Lower Limit	0
					Upper Limit	1
BDEV:Parameter "b" Probability	(none)	Relative value of "b" parameter within the distribution for this soil type	Physical	UNIFORM	Lower Limit	0
					Upper Limit	1
AP:Water Application Rate	(m/y)	Total water application rate on cultivated area	Physical	CONTINUOUS LINEAR	Value	Probability
					0.6071	0
					0.6096	0.4624
					0.635	0.4763
					0.762	0.5404
					0.889	0.6294
					1.016	0.7051
					1.143	0.8039

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					1.27	0.8794
					1.397	0.9414
					1.524	0.9824
					1.651	0.9976
					1.778	1
IR:Irrigation Rate	(L/m**2-d)	Annual average irrigation rate	Behavioral	CONTINUOUS LOG	Value	Probability
					0.371513	0
					0.460623	3.45E-02
					0.505097	6.91E-02
					0.544797	0.103626943
					0.580217	0.138169257
					0.615165	0.172711572
					0.650176	0.207253886
					0.68492	0.2417962
					0.694392	0.250431779
					0.719934	0.276338515
					0.757042	0.310880829
					0.794088	0.345423143
					0.834862	0.379965458
					0.876558	0.414507772
					0.920887	0.449050086
					0.967139	0.483592401
					0.99028	0.499136442
					1.01778	0.518134715
					1.07262	0.552677029
					1.1318	0.587219344
					1.19733	0.621761658
					1.26967	0.656303972
					1.35326	0.690846287
					1.44878	0.725388601
					1.52052	0.749568221
					1.55512	0.759930915
					1.6876	0.79447323
					1.85011	0.829015544
					2.05195	0.863557858
					2.33737	0.898100173
					2.76254	0.932642487
					3.58227	0.967184801
					5.47202	0.991364421
					9.29216	1
RHO1:Surface Soil Density	(g/mL)	Bulk density of soil in the surface soil layer	Physical	DERIVED		
RHO2:Unsaturated Zone Density	(g/mL)	Bulk density of soil in the unsaturated zone	Physical	DERIVED		
Ksat1:Surface Soil Permeabiliy	(cm/sec)	Saturated permeability of the surface soil layer	Physical	DERIVED		
VDR:Volume of Water Consumed	(L)	Volume of water withdrawn for consumptive use	Behavioral	DISCRETE CUMULATIVE	Value	Probability
					54884	0.02
					68847	0.04
					68985	0.06
					71335	0.08
					76036	0.1
					80460	0.12
					82948	0.14
					83916	0.16
					86404	0.18
					89861	0.22
					92073	0.24

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					96911	0.26
					99400	0.28
					99538	0.3
					100644	0.32
					102579	0.34
					103547	0.36
					103685	0.42
					103824	0.48
					103962	0.5
					104930	0.52
					105068	0.54
					107280	0.56
					107694	0.58
					107971	0.6
					109492	0.62
					110598	0.64
					114330	0.66
					114607	0.68
					116266	0.7
					118754	0.72
					119031	0.74
					122072	0.76
					124422	0.78
					137556	0.8
					143086	0.82
					149583	0.84
					159675	0.86
					161196	0.88
					162993	0.9
					165620	0.92
					172532	0.94
					242071	0.96
					261011	0.98
					276218	1
VSW:Volume of Water in Pond	(L)	Volume of water in the pond	Behavioral	CONSTANT	Value	1300000
AR:Cultivated Area	(m**2)	Area of land cultivated	Behavioral	DERIVED		
TTG:Gardening Period	(days)	Total time in gardening period	Behavioral	CONSTANT	Value	90
TD:Drinking-water consumption period	(days)	Drinking-water consumption period	Behavioral	CONSTANT	Value	365.25
ARExt:External Exposure Area	(m**2)	Min surf area to which resident is exposed via external rad during resident period	Behavioral	CONSTANT	Value	200
ARInh:Inhalation Exposure Area	(m**2)	Min surf area to which resident is exposed via inhalation during residential period	Behavioral	CONSTANT	Value	1000
ARIng:Secondary Ingestion Exposure Area	(m**2)	Min surf area to which resi is exposed via secondary ingestion during resid period	Behavioral	CONSTANT	Value	200
ARAgr:Agricultural Exposure Area	(m**2)	Min surf area to which resid is exposed via any agricultural product during resid period	Behavioral	DERIVED		
ARH2O:Groundwater Exposure Area	(m**2)	Min surf area to which resid is exposed via groundwater during residential period	Behavioral	DERIVED		
ARAll:Exposure Area	(m**2)	Min surf area to which resid is exposed via any pathway during the residential period	Behavioral	DERIVED		
DIET:Garden Diet	(none)	Fraction of human diet grown onsite	Behavioral	CONSTANT	Value	1
Uv(1):Diet - Leafy	(kg/y)	Yearly human consumption of leafy vegetables	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					1	0.01
					1.0419771	0.05

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					2.4042882	0.1
					5.8965704	0.25
					11.678991	0.5
					24.577961	0.75
					46.266496	0.9
					66.028747	0.95
					135.51767	0.99
					222.94958	1
Uv(2):Diet - Roots	(kg/y)	Yearly human consumption of other vegetables	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					2.227247	0.01
					4.1520783	0.05
					5.9511124	0.1
					11.27494	0.25
					26.637421	0.5
					55.573628	0.75
					77.073484	0.9
					145.56879	0.95
					301.48693	0.99
					384.02519	1
Uv(3):Diet - Fruit	(kg/y)	Yearly human consumption of fruits	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					1.9304561	0.01
					3.6383867	0.05
					5.0829004	0.1
					9.4811069	0.25
					20.479001	0.5
					45.360963	0.75
					125.95513	0.9
					190.05007	0.95
					460.83695	0.99
					673.56751	1
Uv(4):Diet - Grain	(kg/y)	Yearly human consumption of grains	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					1.4059247	0.01
					2.2237757	0.05
					3.2207749	0.1
					4.8292151	0.25
					8.2018766	0.5
					15.803996	0.75
					31.779351	0.9
					44.00817	0.95
					84.783882	0.99
					99.466253	1
Ua(1):Diet - Beef	(kg/y)	Yearly human consumption of beef	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					2.4236457	0.01
					7.034812	0.05
					8.1970853	0.1
					13.258072	0.25
					28.791752	0.5
					48.407663	0.75
					76.750818	0.9
					105.7057	0.95
					220.05707	0.99

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					222.74866	1
Ua(2):Diet - Poultry	(kg/y)	Yearly human consumption of poultry	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					3.8466442	0.01
					4.1841562	0.05
					5.9362405	0.1
					9.569458	0.25
					19.853647	0.5
					38.218271	0.75
					50.825337	0.9
					58.518625	0.95
					72.813251	0.99
					72.9	1
Ua(3):Diet - Milk	(L/y)	Yearly human consumption of milk	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					6.5899315	0.01
					6.8579431	0.05
					7.672488	0.1
					58.626217	0.25
					148.56249	0.5
					294.81273	0.75
					554.9416	0.9
					721.00367	0.95
					1210.7817	0.99
					1211	1
Ua(4):Diet - Egg	(kg/y)	Yearly human consumption of eggs	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					2.7958156	0.01
					4.5018568	0.05
					5.3004593	0.1
					8.2333802	0.25
					12.360671	0.5
					21.35025	0.75
					35.901778	0.9
					47.35077	0.95
					120.70913	0.99
					121	1
Uf:Diet - Fish	(kg/y)	Yearly human consumption of fish produced from an onsite pond	Behavioral	CONTINUOUS LINEAR	Value	Probability
					0	0
					1.8477969	0.01
					1.9170239	0.05
					2.8419286	0.1
					3.6786896	0.25
					7.7675824	0.5
					16.139546	0.75
					39.081046	0.9
					79.047552	0.95
					112.81583	0.99
					852.05534	1
UW:Diet - Water	(L/d)	Drinking water ingestion rate	Behavioral	LOGNORMAL-N	Mean of Ln(X)	0.15245
					Stand Dev of Ln	0.489
tf:Consumption Period	(days)	Consumption period for fish	Behavioral	CONSTANT	Value	365.25
tcv(1):Consumption Period - Leafy	(days)	Food consumption period for leafy vegetables	Behavioral	CONSTANT	Value	365.25
tcv(2):Consumption Period - Roots	(days)	Food consumption period for other vegetables	Behavioral	CONSTANT	Value	365.25
tcv(3):Consumption Period - Fruit	(days)	Food consumption period for fruits	Behavioral	CONSTANT	Value	365.25

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
tcv(4):Consumption Period - Grain	(days)	Food consumption period for grains	Behavioral	CONSTANT	Value	365.25
tca(1):Consumption Period - Beef	(days)	Food consumption period for beef	Behavioral	CONSTANT	Value	365.25
tca(2):Consumption Period - Poultry	(days)	Food consumption period for poultry	Behavioral	CONSTANT	Value	365.25
tca(3):Consumption Period - Milk	(days)	Food consumption period for milk	Behavioral	CONSTANT	Value	365.25
tca(4):Consumption Period - Egg	(days)	Food consumption period for eggs	Behavioral	CONSTANT	Value	365.25
THV(1):Holdup Period : Leafy	(days)	Holdup period for leafy vegetables	Behavioral	CONSTANT	Value	1
THV(2):Holdup Period : Other vegetables	(days)	Holdup period for other vegetables	Behavioral	CONSTANT	Value	14
THV(3):Holdup Period : Fruits	(days)	Holdup period for fruits	Behavioral	CONSTANT	Value	14
THV(4):Holdup Period : Grains	(days)	Holdup period for grains	Behavioral	CONSTANT	Value	14
THA(1):Holdup Period : Beef	(days)	Holdup period for beef	Behavioral	CONSTANT	Value	20
THA(2):Holdup Period : Poultry	(days)	Holdup period for poultry	Behavioral	CONSTANT	Value	1
THA(3):Holdup Period : Milk	(days)	Holdup period for milk	Behavioral	CONSTANT	Value	1
THA(4):Holdup Period : Eggs	(days)	Holdup period for eggs	Behavioral	CONSTANT	Value	1
TGV(1):Growing Period : Leafy	(days)	Minimum growing period for leafy vegetables	Physical	CONSTANT	Value	45
TGV(2):Growing Period : Other vegetables	(days)	Minimum growing period for other vegetables	Physical	CONSTANT	Value	90
TGV(3):Growing Period : Fruits	(days)	Minimum growing period for fruits	Physical	CONSTANT	Value	90
TGV(4):Growing Period : Grains	(days)	Minimum growing period for grains	Physical	CONSTANT	Value	90
TGF(1):Growing Period : Beef Forage	(days)	Minimum growing period for forage consumed by beef cattle	Physical	CONSTANT	Value	30
TGF(2):Growing Period : Poultry Forage	(days)	Minimum growing period for forage consumed by poultry	Physical	DERIVED		
TGF(3):Growing Period : Milk Cow Forage	(days)	Minimum growing period for forage consumed by milk cows	Physical	DERIVED		
TGF(4):Growing Period : Layer Hen Forage	(days)	Minimum growing period for forage consumed by layer hens	Physical	DERIVED		
TGG(1):Growing Period : Beef Cow Grain	(days)	Minimum growing period for stored grain consumed by beef cattle	Physical	CONSTANT	Value	90
TGG(2):Growing Period : Poultry Grain	(days)	Minimum growing period for stored grain consumed by poultry	Physical	DERIVED		
TGG(3):MGrowing Period : Milk Cow Grain	(days)	Minimum growing period for stored grain consumed by milk cows	Physical	DERIVED		
TGG(4):Growing Period : Layer Hen Grain	(days)	Minimum growing period for stored grain consumed by layer hens	Physical	DERIVED		
TGH(1):Growing Period : Beef Cow Hay	(days)	Minimum growing period for stored hay consumed by beef cattle	Physical	CONSTANT	Value	45
TGH(2):Growing Period : Poultry Hay	(days)	Minimum growing period for stored hay consumed by poultry	Physical	DERIVED		
TGH(3):Growing Period : Milk Cow Hay	(days)	Minimum growing period for stored hay consumed by milk cows	Physical	DERIVED		
TGH(4):Growing Period : Layer Hen Hay	(days)	Minimum growing period for stored hay consumed by layer hens	Physical	DERIVED		
SATac:Animal Product Specific Activity	(none)	Spec activ equivalence of animal product and spec activ of animal feed, forage, and soil	Physical	CONSTANT	Value	1
sh:Soil Moisture Content	(L/m**3)	Moisture content of soil	Physical	DERIVED		
TFF(1):Feeding Period : Beef Cow Forage	(days)	Feeding period for beef cattle forage	Physical	CONSTANT	Value	365.25
TFF(2):Feeding Period : Poultry Forage	(days)	Feeding period for poultry forage	Physical	CONSTANT	Value	365.25
TFF(3):Feeding Period : Milk Cow Forage	(days)	Feeding period for milk cow forage	Physical	CONSTANT	Value	365.25
TFF(4):Feeding Period : Layer Hen Forage	(days)	Feeding period for layer hen forage	Physical	CONSTANT	Value	365.25
TFG(1):Feeding Period : Beef Cattle Grain	(days)	Feeding period for beef cattle grain	Physical	CONSTANT	Value	365.25
TFG(2):Feeding Period : Poultry Grain	(days)	Feeding period for poultry grain	Physical	CONSTANT	Value	365.25
TFG(3):Feeding Period : Milk Cow Grain	(days)	Feeding period for milk cow grain	Physical	CONSTANT	Value	365.25
TFG(4):Feeding Period : Layer Hen Grain	(days)	Feeding period for layer hen grain	Physical	CONSTANT	Value	365.25
TFH(1):Feeding Period : Beef Cattle Hay	(days)	Feeding period for beef cattle hay	Physical	CONSTANT	Value	365.25
TFH(2):Feeding Period : Poultry Hay	(days)	Feeding period for poultry hay	Physical	CONSTANT	Value	365.25
TFH(3):Feeding Period : Milk Cow Hay	(days)	Feeding period for milk cow hay	Physical	CONSTANT	Value	365.25
TFH(4):Feeding Period : Layer Hen Hay	(days)	Feeding period for layer hen hay	Physical	CONSTANT	Value	365.25
TFW(1):Water Period : Beef Cattle	(days)	Water ingestion period for beef cattle	Physical	CONSTANT	Value	365.25
TFW(2):Water Period : Poultry	(days)	Water ingestion period for poultry	Physical	CONSTANT	Value	365.25
TFW(3):Water Period : Milk Cows	(days)	Water ingestion period for milk cows	Physical	CONSTANT	Value	365.25
TFW(4):Water Period : Layer Hens	(days)	Water ingestion period for layer hens	Physical	CONSTANT	Value	365.25
YA(1):Animal Product Yield : Beef Cattle	(kg/y)	Annual yield of beef per individual animal	Physical	CONSTANT	Value	209
YA(2):Animal Product Yield : Poultry	(kg/y)	Annual yield of chicken per individual animal	Physical	CONSTANT	Value	1.53
YA(3):Animal Product Yield : Milk Coes	(L/y)	Annual yield of milk per individual animal	Physical	CONSTANT	Value	7414
YA(4):Animal Product Yield : Layer Hens	(kg/y)	Annual yield of eggs per individual animal	Physical	CONSTANT	Value	12.6
RV(1):Interception Fraction : Leafy	(none)	Interception fraction for leafy vegetables	Physical	UNIFORM	Lower Limit	0.1
					Upper Limit	0.6
RV(2):Interception Fraction : Other vegetables	(none)	Interception fraction for other vegetables	Physical	UNIFORM	Lower Limit	0.1

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					Upper Limit	0.6
RV(3):Interception Fraction : Fruits	(none)	Interception fraction for fruits	Physical	UNIFORM	Lower Limit	0.1
					Upper Limit	0.6
RV(4):Interception Fraction : Grains	(none)	Interception fraction for grains	Physical	UNIFORM	Lower Limit	0.1
					Upper Limit	0.6
RF(1):Interception Fraction : Beef Forage	(none)	Interception fraction for beef cattle forage	Physical	UNIFORM	Lower Limit	0.1
					Upper Limit	0.6
RF(2):Interception Fraction : Poultry forage	(none)	Interception fraction for poultry forage	Physical	DERIVED		
RF(3):Interception Fraction : Milk Cow Forage	(none)	Interception fraction for milk cow forage	Physical	DERIVED		
RF(4):Interception Fraction : Layer Hen Forage	(none)	Interception fraction for layer hen forage	Physical	DERIVED		
RG(1):Interception Fraction : Beef Cow Grain	(none)	Interception fraction for beef cattle grain	Physical	UNIFORM	Lower Limit	0.1
					Upper Limit	0.6
RG(2):Interception Fraction : Poultry Grain	(none)	Interception fraction for poultry grain	Physical	DERIVED		
RG(3):Interception Fraction : Milk Cow Grain	(none)	Interception fraction for milk cow grain	Physical	DERIVED		
RG(4):Interception Fraction : Layer Hen Grain	(none)	Interception fraction for layer hen grain	Physical	DERIVED		
RH(1):Interception Fraction : Beef Cow Hay	(none)	Interception fraction for beef cattle hay	Physical	DERIVED		
RH(2):Interception Fraction : Poultry Hay	(none)	Interception fraction for poultry hay	Physical	DERIVED		
RH(3):Interception Fraction : Milk Cow Hay	(none)	Interception fraction for milk cow hay	Physical	DERIVED		
RH(4):Interception Fraction : Layer Hen Hay	(none)	Interception fraction for layer hen hay	Physical	DERIVED		
Tv(1):Translocation:Leafy	(none)	Translocation factor for leafy vegetables	Physical	CONSTANT	Value	1
Tv(2):Translocation:Root	(none)	Translocation factor for other vegetables	Physical	CONSTANT	Value	0.1
Tv(3):Translocation:Fruit	(none)	Translocation factor for fruit	Physical	CONSTANT	Value	0.1
Tv(4):Translocation:Grain	(none)	Translocation factor for grain	Physical	CONSTANT	Value	0.1
Tf(1):Translocation:Beef Forage	(none)	Translocation factor for forage consumed by beef cattle	Physical	CONSTANT	Value	1
Tf(2):Translocation:Poultry Forage	(none)	Translocation factor for forage consumed by poultry	Physical	CONSTANT	Value	1
Tf(3):Translocation:Translocation:	(none)	Translocatioin factor for forage consumed by milk cows	Physical	CONSTANT	Value	1
Tf(4):Translocation:Layer Hen Forage	(none)	Translocation factor for forage consumed by layer hens	Physical	CONSTANT	Value	1
Tg(1):Translocation:Beef Grain	(none)	Translocation factor for stored grain consumed by beef cattle	Physical	CONSTANT	Value	0.1
Tg(2):Translocation:Poultry Grain	(none)	Translocation factor for stored grain consumed by poultry	Physical	CONSTANT	Value	0.1
Tg(3):Translocation:Milk Cow Grain	(none)	Translocation factor for stored grain consumed by milk cows	Physical	CONSTANT	Value	0.1
Tg(4):Translocation:Layer Hen Grain	(none)	Translocation factor for stored grain consumed by layer hens	Physical	CONSTANT	Value	0.1
Th(1):Translocation:Beef Hay	(none)	Translocation factor for stored hay consumed by beef cattle	Physical	CONSTANT	Value	1
Th(2):Translocation:Poultry Hay	(none)	Translocation factor for stored hay consumed by poultry	Physical	CONSTANT	Value	1
Th(3):Translocation:Milk Cow Hay	(none)	Translocation factor for stored hay consumed by milk cows	Physical	CONSTANT	Value	1
Th(4):Translocation:Layer Hen Hay	(none)	Translocation factor for stored hay consumed by layer hens	Physical	CONSTANT	Value	1
xf(1):Beef Forage Contaminated Fraction	(none)	Fraction of forage consumed by beef cattle that is contaminated	Physical	CONSTANT	Value	1
xf(2):Poultry Forage Contaminated Fraction	(none)	Fraction of forage consumed by poultry that is contaminated	Physical	CONSTANT	Value	1
xf(3):Milk Cow Forage Contaminated Fraction	(none)	Fraction of forage consumed by milk cows that is contaminated	Physical	CONSTANT	Value	1
xf(4):Layer Hen Forage Contaminated Fraction	(none)	Fraction of forage consumed by layer hens that is contaminated	Physical	CONSTANT	Value	1
xg(1):Beef Grain Contaminated Fraction	(none)	Fraction of stored grain consumed by beef cattle that is contaminated	Physical	CONSTANT	Value	1
xg(2):Poultry Grain Contaminated Fraction	(none)	Fraction of stored grain consumed by poultry that is contaminated	Physical	CONSTANT	Value	1
xg(3):Milk Cow Grain Contaminated Fraction	(none)	Fraction of stored grain consumed by milk cows that is contaminated	Physical	CONSTANT	Value	1
xg(4):Layer Hen Grain Contaminated Fraction	(none)	Fraction of stored grain that is consumed by layer hens that is contaminated	Physical	CONSTANT	Value	1
xh(1):Beef Hay Contaminated Fraction	(none)	Fraction of stored hay consumed by beef cattle that is contaminated	Physical	CONSTANT	Value	1
xh(2):Poultry Hay Contaminated Fraction	(none)	Fraction of stored hay consumed by poultry that is contaminated	Physical	CONSTANT	Value	1
xh(3):Milk Cow Hay Contaminated Fraction	(none)	Fraction of stored hay consumed by milk cows that is contaminated	Physical	CONSTANT	Value	1
xh(4):Layer Hen Hay Contaminated Fraction	(none)	Fraction of stored hay consumed by layer hens that is contaminated	Physical	CONSTANT	Value	1
xw(1):Beef Water Contaminated Fraction	(none)	Fraction of water that is consumed by beef cattle that is contaminated	Physical	CONSTANT	Value	1
xw(2):Poultry Water Contaminated Fraction	(none)	Fraction of water consumed by poultry that is contaminated	Physical	CONSTANT	Value	1
xw(3):Milk Cow Water Contaminated Fraction	(none)	Fraction of water consumed by milk cows that is contaminated	Physical	CONSTANT	Value	1
xw(4):Layer Hen Water Contaminated Fraction	(none)	Fraction of water consumed by layer hens that is contaminated	Physical	CONSTANT	Value	1
YV(1):Crop Yield : Leafy	(kg wet wt/m**2)	Crop yield for leafy vegetables	Physical	CONTINUOUS LINEAR	Value	Probability
					2.7	0
					2.713438	0.0016
					2.735421	0.006

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					2.757405	0.0176
					2.779388	0.0436
					2.801372	0.0848
					2.823355	0.156
					2.845338	0.2568
					2.867322	0.3636
					2.889305	0.5004
					2.911288	0.6392
					2.933272	0.7456
					2.955256	0.8416
					2.977239	0.9092
					2.999222	0.9604
					3.021206	0.984
					3.043189	0.9936
					3.065172	0.9972
					3.087156	0.9988
					3.109139	0.9996
					3.131123	0.9998
					3.153106	1
YV(2):Crop Yeild : Other	(kg wet wt/m**2)	Crop yield for other vegetables	Physical	CONTINUOUS LINEAR	Value	Probability
					2.26	0
					2.28714	0.0008
					2.299984	0.0012
					2.312828	0.0064
					2.325672	0.0152
					2.338516	0.0328
					2.35136	0.0744
					2.364204	0.14
					2.377048	0.2492
					2.389892	0.38
					2.402736	0.53
					2.41558	0.6612
					2.428424	0.7876
					2.441268	0.8856
					2.454112	0.9416
					2.466956	0.9748
					2.4798	0.9884
					2.492644	0.996
					2.505488	0.9972
					2.518332	0.9992
					2.531176	0.9996
					2.54402	1
YV(3):Crop Yield : Fruits	(kg wet wt/m**2)	Crop yield for fruits	Physical	CONTINUOUS LINEAR	Value	Probability
					2.17	0
					2.194561	0.0012
					2.212967	0.0024
					2.231374	0.0068
					2.24978	0.018
					2.268186	0.0436
					2.286592	0.0764
					2.304999	0.138
					2.323405	0.2136
					2.341811	0.3272
					2.360218	0.45
					2.378624	0.5764

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					2.39703	0.6868
					2.415437	0.7876
					2.433843	0.868
					2.452249	0.9248
					2.470655	0.9604
					2.489062	0.9808
					2.507468	0.9916
					2.525874	0.998
					2.544281	0.9996
					2.562687	1
YV(4):Crop Yield : Grains	(kg wet wt/m**2)	Crop yield for grains	Physical	CONTINUOUS LINEAR	Value	Probability
					0.285	0
					0.2897287	0.0006
					0.3017949	0.0028
					0.313861	0.0094
					0.3259272	0.0214
					0.3379934	0.0542
					0.3500596	0.1082
					0.3621257	0.2022
					0.3741919	0.3146
					0.3862581	0.4504
					0.3983243	0.5916
					0.4103904	0.7202
					0.4224566	0.8256
					0.4345227	0.903
					0.4465889	0.951
					0.4586551	0.9768
					0.4707212	0.9912
					0.4827874	0.9958
					0.4948536	0.999
					0.5069197	0.9996
					0.5189859	0.9998
					0.5310521	1
YF(1):Crop Yield : Beef Forage	(kg dry wt forage/m**2)	Crop yield for beef cattle forage	Physical	BETA	Lower Limit	0.3702
					Upper Limit	0.5238
					p	2.36439
					q	1.259357
YF(2):Crop Yield : Poultry Forage	(kg wet wt forage/m**2)	Crop yield for poultry forage	Physical	DERIVED		
YF(3):Crop Yield : Milk Cow Forage	(kg wet wt forage/m**2)	Crop yield for milk cow forage	Physical	DERIVED		
YF(4):Crop Yield : Layer Hen Forage	(kg wet wt forage/m**2)	Crop yield for layer hen forage	Physical	DERIVED		
YG(1):Crop Yield : Beef Cow Grain	(kg dry wt grain /m**2)	Crop yield for beef cattle grain	Physical	NORMAL	Mean	0.57818729
					Stand Dev of Ln	0.077651595
YG(2):Crop Yield : Poultry Grain	(kg wet wt grain /m**2)	Crop yield for poultry grain	Physical	DERIVED		
YG(3):Crop Yield : Milk Cow Grain	(kg wet wt grain /m**2)	Crop yield for milk cow grain	Physical	DERIVED		
YG(4):Crop Yield : Layer Hen Grain	(kg wet wt grain /m**2)	Crop yield for layer hen grain	Physical	DERIVED		
YH(1):Crop Yield : Beef Cow Hay	(kg wet wt/m**2)	Crop yield for beef cattle hay	Physical	DERIVED		
YH(2):Crop Yield : Poultry Hay	(kg wet wt/m**2)	Crop yield for poultry hay	Physical	DERIVED		
YH(3):Crop Yield : Milk Cow Hay	(kg wet wt/m**2)	Crop yield for milk cow hay	Physical	DERIVED		
YH(4):Crop Yield : Layer Hen Hay	(kg wet wt/m**2)	Crop yield for layer hen hay	Physical	DERIVED		
WV(1):Wet/dry : Leafy Vegetables	(none)	Wet/dry conversion factor for leafy vegetables	Physical	CONTINUOUS LINEAR	Value	Probability
					0.0331917	0
					0.0489258	3.45E-02
					0.0547462	6.91E-02
					0.0595952	0.103626943
					0.0635918	0.138169257

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					0.0670311	0.172711572
					0.0704904	0.207253886
					0.0737596	0.2417962
					0.0747625	0.250431779
					0.0771995	0.276338515
					0.0803141	0.310880829
					0.0833909	0.345423143
					0.0865838	0.379965458
					0.0900403	0.414507772
					0.0935944	0.449050086
					0.0973438	0.483592401
					0.0990564	0.499136442
					0.101372	0.518134715
					0.105445	0.552677029
					0.109378	0.587219344
					0.113381	0.621761658
					0.117963	0.656303972
					0.123072	0.690846287
					0.128923	0.725388601
					0.133049	0.749568221
					0.134913	0.759930915
					0.142239	0.79447323
					0.150093	0.829015544
					0.158987	0.863557858
					0.170001	0.898100173
					0.184928	0.932642487
					0.210237	0.967184801
					0.255863	0.991364421
					0.324148	1
WV(2):Wet/dry : Other Vegetables	(none)	Wet/dry conversion factor for other vegetables	Physical	CONTINUOUS LINEAR	Value	Probability
					0.0357558	0
					0.0486646	3.45E-02
					0.0546334	6.91E-02
					0.0589704	0.103626943
					0.062919	0.138169257
					0.0668567	0.172711572
					0.070153	0.207253886
					0.0734402	0.2417962
					0.0741101	0.250431779
					0.0765031	0.276338515
					0.0798988	0.310880829
					0.0832252	0.345423143
					0.0865798	0.379965458
					0.0904737	0.414507772
					0.0941375	0.449050086
					0.098161	0.483592401
					0.0998397	0.499136442
					0.101882	0.518134715
					0.105951	0.552677029
					0.109438	0.587219344
					0.114024	0.621761658
					0.118831	0.656303972
					0.123661	0.690846287
					0.129395	0.725388601
					0.133328	0.749568221

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					0.135377	0.759930915
					0.141876	0.79447323
					0.149563	0.829015544
					0.159077	0.863557858
					0.170438	0.898100173
					0.186615	0.932642487
					0.212304	0.967184801
					0.262477	0.991364421
					0.312735	1
WV(3):Wet/dry : Fruit	(none)	Wet/dry conversion factor for fruits	Physical	CONTINUOUS LINEAR	Value	Probability
					0.0366097	0
					0.0487498	3.45E-02
					0.0545019	6.91E-02
					0.0593211	0.103626943
					0.0630524	0.138169257
					0.0671859	0.172711572
					0.0709846	0.207253886
					0.0743581	0.2417962
					0.0751691	0.250431779
					0.0778021	0.276338515
					0.0812687	0.310880829
					0.0844876	0.345423143
					0.0878489	0.379965458
					0.0911296	0.414507772
					0.0945513	0.449050086
					0.098171	0.483592401
					0.0996768	0.499136442
					0.101877	0.518134715
					0.105742	0.552677029
					0.109784	0.587219344
					0.114127	0.621761658
					0.118758	0.656303972
					0.123734	0.690846287
					0.129406	0.725388601
					0.133593	0.749568221
					0.135415	0.759930915
					0.142073	0.79447323
					0.148934	0.829015544
					0.158432	0.863557858
					0.169738	0.898100173
					0.187073	0.932642487
					0.213875	0.967184801
					0.257778	0.991364421
					0.324575	1
WV(4):Wet/dry : Grain	(none)	Wet/dry conversion factor for grains	Physical	CONSTANT	Value	0.88
WF(1):Wet/dry : Beef Cow Forage	(none)	Wet/dry conversion factor for beef cattle forage	Physical	BETA	Lower Limit	0.183
					Upper Limit	0.323
					p	1.15
					q	1.18
WF(2):Wet/dry : Poultry Forage	(none)	Wet/dry conversion factor for poultry forage	Physical	DERIVED		
WF(3):Wet/dry : Milk Cow Forage	(none)	Wet/dry conversion factor for milk cow forage	Physical	DERIVED		
WF(4):Wet/dry : Layer Hen Forage	(none)	Wet/dry conversion factor for layer hen forage	Physical	DERIVED		
WG(1):Wet/dry : Beef Cow Grain	(none)	Wet/dry conversion factor for beef cattle grain	Physical	CONSTANT	Value	0.88
WG(2):Wet/dry : Poultry Grain	(none)	Wet/dry conversion factor for poultry grain	Physical	DERIVED		
WG(3):Wet/dry : Milk Cow Grain	(none)	Wet/dry conversion factor for milk cow grain	Physical	DERIVED		

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
WG(4):Wet/dry : Layer Hen Grain	(none)	Wet/dry conversion factor for layer hen grain	Physical	DERIVED		
WH(1):Wet/dry : Beef Cow Hay	(none)	Wet/dry conversion factor for beef cattle hay	Physical	DERIVED		
WH(2):Wet/dry : Poultry Hay	(none)	Wet/dry conversion factor for poultry hay	Physical	DERIVED		
WH(3):Wet/dry : Milk Cow Hay	(none)	Wet/dry conversion factor for milk cow hay	Physical	DERIVED		
WH(4):Wet/dry : Layer Hen Hay	(none)	Wet/dry conversion factor for layer hen hay	Physical	DERIVED		
QF(1):Ingestion Rate : Beef Cow Forage	(kg dry wt forage/d)	Ingestion rate for beef cattle forage	Physical	BETA	Lower Limit	1.69026
					Upper Limit	2.28954
					p	1.9904747
					q	0.91123692
QF(2):Ingestion Rate : Poultry Forage	(kg dry wt forage/d)	Ingestion rate for poultry forage	Physical	BETA	Lower Limit	0.00348
					Upper Limit	0.0282
					p	1.5087441
					q	1.4116037
QF(3):Ingestion Rate : Milk Cow Forage	(kg dry wt forage/d)	Ingestion rate for milk cow forage	Physical	CONTINUOUS LINEAR	Value	Probability
					6.348790603	0
					6.772385742	3.45E-02
					6.959223873	6.91E-02
					7.104045676	0.103626943
					7.235260781	0.138169257
					7.346738894	0.172711572
					7.468175453	0.207253886
					7.568803549	0.2417962
					7.597139073	0.250431779
					7.671702816	0.276338515
					7.765301866	0.310880829
					7.872427054	0.345423143
					7.976715393	0.379965458
					8.079224453	0.414507772
					8.181056473	0.449050086
					8.307807367	0.483592401
					8.3659693	0.499136442
					8.424465107	0.518134715
					8.541303799	0.552677029
					8.665595368	0.587219344
					8.808221657	0.621761658
					8.94970739	0.656303972
					9.101183823	0.690846287
					9.260240173	0.725388601
					9.383095556	0.749568221
					9.447933618	0.759930915
					9.680069418	0.79447323
					9.929881811	0.829015544
					10.21000192	0.863557858
					10.60522652	0.898100173
					11.11696731	0.932642487
					11.96532995	0.967184801
					13.28908846	0.991364421
					15.33512635	1
QF(4):Ingestion Rate : Layer Hen Forage	(kg dry wt forage/d)	Ingestion rate for layer hen forage	Physical	BETA	Lower Limit	0.0119
					Upper Limit	0.0222
					p	1.450073
					q	0.79164077
QG(1):Ingestion Rate : Beef Cattle Grain	(kg dry wt grain/d)	Ingestion rate for beef cattle grain	Physical	BETA	Lower Limit	1.69026
					Upper Limit	2.28954
					p	1.9904747

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
					q	0.91123692
QG(2):Ingestion Rate : Poultry Grain	(kg dry wt grain/d)	Ingestion rate for poultry grain	Physical	BETA	Lower Limit	0.0104
					Upper Limit	0.0845
					p	1.5087441
					q	1.4116037
QG(3):Ingestion Rate : Milk Cow Grain	(kg dry wt grain/d)	Ingestion rate for milk cow grain	Physical	NORMAL	Mean	1.7135556
					Stand Dev of Ln	0.26199017
QG(4):Ingestion Rate : Layer Hen Grain	(kg dry wt grain/d)	Ingestion rate for layer hen grain	Physical	BETA	Lower Limit	0.0358
					Upper Limit	0.0667
					p	1.4250073
					q	0.79164077
QH(1):Ingestion Rate : Beef Cattle Hay	(kg wet wt hay/d)	Ingestion rate for beef cattle hay	Physical	BETA	Lower Limit	3.38052
					Upper Limit	4.57908
					p	1.9904747
					q	0.91123692
QH(2):Ingestion Rate : Poultry Hay	(kg dry wt hay/d)	Ingestion rate for poultry hay	Physical	CONSTANT	Value	0
QH(3):Ingestion Rate : Milk Cow Hay	(kg wet wt hay/d)	Ingestion rate for milk cow hay	Physical	CONTINUOUS LINEAR	Value	Probability
					5.117303678	0
					5.429864349	3.45E-02
					5.573394383	6.91E-02
					5.68300236	0.103626943
					5.790760793	0.138169257
					5.887253467	0.172711572
					5.978050649	0.207253886
					6.060278708	0.2417962
					6.076545413	0.250431779
					6.13816704	0.276338515
					6.218287928	0.310880829
					6.297126294	0.345423143
					6.377991499	0.379965458
					6.457329976	0.414507772
					6.538412802	0.449050086
					6.626302519	0.483592401
					6.665886864	0.499136442
					6.718679898	0.518134715
					6.814431645	0.552677029
					6.919830563	0.587219344
					7.028286509	0.621761658
					7.134990994	0.656303972
					7.262629993	0.690846287
					7.391623202	0.725388601
					7.489467774	0.749568221
					7.5559063	0.759930915
					7.700834267	0.79447323
					7.89076167	0.829015544
					8.107550319	0.863557858
					8.388162173	0.898100173
					8.754387245	0.932642487
					9.440470515	0.967184801
					10.48579433	0.991364421
					12.67701709	1
QH(4):Ingestion Rate : Layer Hen Hay	(kg dry wt hay/d)	Ingestion rate for layer hen hay	Physical	CONSTANT	Value	0
QW(1):Water Rate : Beef Cattle	(L/d)	Water ingestion rate for beef cattle	Physical	CONSTANT	Value	50
QW(2):Water Rate : Poultry	(L/d)	Water ingestion rate for poultry	Physical	CONSTANT	Value	0.3
QW(3):Water Rate : Milk Cows	(L/d)	Water ingestion rate for milk cows	Physical	CONSTANT	Value	60

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
QW(4):Water Rate : Layer Hens	(L/d)	Water ingestion rate for layer hens	Physical	CONSTANT	Value	0.3
QD(1):Soil Fraction : Beef Cattle	(none)	Soil intake fraction for beef cattle	Physical	CONSTANT	Value	0.02
QD(2):Soil Fraction : Poultry	(none)	Soil intake fraction for poultry	Physical	CONSTANT	Value	0.1
QD(3):Soil Fraction : Milk Cows	(none)	Soil intake fraction for milk cows	Physical	CONSTANT	Value	0.02
QD(4):Soil Fraction : Layer Hens	(none)	Soil intake fraction for layer hens	Physical	CONSTANT	Value	0.1
MLV(1):Mass-Loading : Leafy Vegetables	(none)	Mass-loading factor for leafy vegetables	Physical	CONSTANT	Value	0.1
MLV(2):Mass-Loading : Other Vegetables	(none)	Mass-loading factor for other vegetables	Physical	CONSTANT	Value	0.1
MLV(3):Mass-Loading : Fruits	(none)	Mass-loading factor for fruits	Physical	CONSTANT	Value	0.1
MLV(4):Mass-Loading : Grains	(none)	Mass-loading factor for grains	Physical	CONSTANT	Value	0.1
LAMBDW:Weathering Rate	(1/d)	Weathering rate for activity removal from plants	Physical	CONSTANT	Value	0.0495
MLF(1):Mass-Loading : Beef Cow Forage	(none)	Mass-loading factor for beef cattle forage	Physical	CONSTANT	Value	0.1
MLF(2):Mass-Loading : Poultry Forage	(none)	Mass-loading factor for poultry forage	Physical	CONSTANT	Value	0.1
MLF(3):Mass-Loading : Milk Cow Forage	(none)	Mass-loading factor for milk cow forage	Physical	CONSTANT	Value	0.1
MLF(4):Mass-Loading : Layer Hen Forage	(none)	Mass-loading factor for layer hen forage	Physical	CONSTANT	Value	0.1
MLG(1):Mass-Loading : Beef Cattle Grain	(none)	Mass-loading factor for beef cattle grain	Physical	CONSTANT	Value	0.1
MLG(2):Mass-Loading : Poultry Grain	(none)	Mass-loading factor for poultry grain	Physical	CONSTANT	Value	0.1
MLG(3):Mass-Loading : Milk Cow Grain	(none)	Mass-loading factor for milk cow grain	Physical	CONSTANT	Value	0.1
MLG(4):Mass-Loading : Layer Hen Grain	(none)	Mass-loading factor for layer hen grain	Physical	CONSTANT	Value	0.1
MLH(1):Mass-Loading : Beef Cattle Hay	(none)	Mass-loading factor for beef cattle hay	Physical	CONSTANT	Value	0.1
MLH(2):Mass-Loading : Poultry Hay	(none)	Mass-loading factor for poultry hay	Physical	CONSTANT	Value	0.1
MLH(3):Mass-Loading : Milk Cow Hay	(none)	Mass-loading factor for milk cow hay	Physical	CONSTANT	Value	0.1
MLH(4):Mass-Loading : Layer Hen Hay	(none)	Mass-loading factor for layer hen hay	Physical	CONSTANT	Value	0.1
fca(1):Beef Carbon Fraction	(none)	Mass fraction of beef cattle that is carbon	Physical	CONSTANT	Value	0.36
fca(2):Poultry Carbon Fraction	(none)	Mass fraction of poultry that is carbon	Physical	CONSTANT	Value	0.18
fca(3):Milk Carbon Fraction	(none)	Mass fraction of milk that is carbon	Physical	CONSTANT	Value	0.06
fca(4):Eggs Carbon Fraction	(none)	Mass fraction of an egg that is carbon	Physical	CONSTANT	Value	0.16
fcf(1):Beef Forage Carbon Fraction	(none)	Mass fraction of wet forage consumed by beef cattle that is carbon	Physical	CONSTANT	Value	0.11
fcf(2):Poultry Forage Carbon Fraction	(none)	Mass fraction of wet forage consumed by poultry that is carbon	Physical	CONSTANT	Value	0.11
fcf(3):Milk Cow Forage Carbon Fraction	(none)	Mass fraction of wet forage consumed by milk cows that is carbon	Physical	CONSTANT	Value	0.11
fcf(4):Layer Hen Forage Carbon Fraction	(none)	Mass fraction of wet forage consumed by layer hens that is carbon	Physical	CONSTANT	Value	0.11
fcg(1):Beef Grain Carbon Fraction	(none)	Mass fraction of wet stored grain consumed by beef cattle that is carbon	Physical	CONSTANT	Value	0.4
fcg(2):Poultry Grain Carbon Fraction	(none)	Mass fraction of wet stored grain consumed by poultry that is carbon	Physical	CONSTANT	Value	0.4
fcg(3):Milk Cow Grain Carbon Fraction	(none)	Mass fraction of wet stored grain consumed by milk cows that is carbon	Physical	CONSTANT	Value	0.4
fcg(4):Layer Hen Grain Carbon Fraction	(none)	Mass fraction of wet stored grain consumed by layer hens that is carbon	Physical	CONSTANT	Value	0.4
fch(1):Beef Hay Carbon Fraction	(none)	Mass fraction of wet stored hay consumed by beef cattle that is carbon	Physical	CONSTANT	Value	0.07
fch(2):Poultry Hay Carbon Fraction	(none)	Mass fraction of wet stored hay consumed by poultry that is carbon	Physical	CONSTANT	Value	0.07
fch(3):Milk Cow Hay Carbon Fraction	(none)	Mass fraction of wet stored hay consumed by milk cows that is carbon	Physical	CONSTANT	Value	0.07
fch(4):Layer Hen Hay Carbon Fraction	(none)	Mass fraction of wet stored hay consumed by layer hens that is carbon	Physical	CONSTANT	Value	0.07
fCd:Soil Carbon Fraction	(none)	Mass fraction of dry soil that is carbon	Physical	CONSTANT	Value	0.03
fha(1):Hydrogen Fraction : Beef Cattle	(none)	Hydrogen fraction for beef cattle	Physical	CONSTANT	Value	0.1
fha(2):Hydrogen Fraction : Poultry	(none)	Hydrogen fraction for poultry	Physical	CONSTANT	Value	0.1
fha(3):Hydrogen Fraction : Milk Cows	(none)	Hydrogen fraction for milk cows	Physical	CONSTANT	Value	0.11
fha(4):Hydrogen Fraction : Layer Hens	(none)	Hydrogen fraction for layer hens	Physical	CONSTANT	Value	0.11
fhv(1):Hydrogen Fraction : Leafy Vegetables	(none)	Hydrogen fraction for leafy vegetables	Physical	CONSTANT	Value	0.1
fhv(2):Hydrogen Fraction : Other Vegetables	(none)	Hydrogen fraction for other vegetables	Physical	CONSTANT	Value	0.1
fhv(3):Hydrogen Fraction : Fruits	(none)	Hydrogen fraction for fruits	Physical	CONSTANT	Value	0.1
fhv(4):Hydrogen Fraction : Grains	(none)	Hydrogen fraction for grains	Physical	CONSTANT	Value	0.068
fhf(1):Hydrogen Fraction : Beef Cow Forage	(none)	Hydrogen fraction for beef cattle forage	Physical	CONSTANT	Value	0.1
fhf(2):Hydrogen Fraction : Poultry Forage	(none)	Hydrogen fraction for poultry forage	Physical	CONSTANT	Value	0.1
fhf(3):Hydrogen Fraction : Milk Cow Forage	(none)	Hydrogen fraction for milk cow forage	Physical	CONSTANT	Value	0.1
fhf(4):Hydrogen Fraction : Layer Hen Forage	(none)	Hydrogen fraction for layer hen forage	Physical	CONSTANT	Value	0.1
fhh(1):Hydrogen Fraction : Beef Cattle Hay	(none)	Hydrogen fraction for beef cattle hay	Physical	CONSTANT	Value	0.1
fhh(2):Hydrogen Fraction : Poultry Hay	(none)	Hydrogen fraction for poultry hay	Physical	CONSTANT	Value	0.1
fhh(3):Hydrogen Fraction : Milk Cow Hay	(none)	Hydrogen fraction for milk cow hay	Physical	CONSTANT	Value	0.1
fhh(4):Hydrogen Fraction : Layer Hen Hay	(none)	Hydrogen fraction for layer hen hay	Physical	CONSTANT	Value	0.1

Table C7.3 Default Parameter Distributions and Values for DandD Residential Scenario (continued)

Parameter symbol:name	Units	Description	Classification	Distribution	Value	
fhg(1):Hydrogen Fraction : Beef Cattle Grain	(none)	Hydrogen fraction for beef cattle grain	Physical	CONSTANT	Value	0.068
fhg(2):Hydrogen Fraction : Poultry Grain	(none)	Hydrogen fraction for poultry grain	Physical	CONSTANT	Value	0.068
fhg(3):Hydrogen Fraction : Milk Cow Grain	(none)	Hydrogen fraction for milk cow grain	Physical	CONSTANT	Value	0.068
fhg(4):Hydrogen Fraction : Layer Hen Grain	(none)	Hydrogen fraction for layer hen grain	Physical	CONSTANT	Value	0.068
fhd016:Hydrogen Fraction : Soil	(none)	Fraction of hydrogen in soil	Physical	DERIVED		
sasvh:Tritium Equivalence: Plant/Soil	(none)	Tritium equivalence: plant/soil	Physical	CONSTANT	Value	1
sawvh:Tritium Equivalence: Plant/Water	(none)	Tritium equivalence: plant/water	Physical	CONSTANT	Value	1
satah:Tritium Equivalence: Animal Products	(none)	Tritium equivalence: animal product intake	Physical	CONSTANT	Value	1

Table C7.4 Assigned Distribution Types and Distribution Statistical Parameters for RESRAD-BUILD Parameters

Parameter	Classification	Assigned Distribution Type	Distribution's Statistical Parameters			
			1	2	3	4
Removable fraction	Physical, Behavioral	Triangular	0	1	0.2	
Resuspension rate (1/s)	Physical, Behavioral	Loguniform	0	0.00001		
Shielding density (g/cm^3)	Physical	Uniform	2.2	2.6		
Source density, volume source (g/cm^3)	Physical	Uniform	2.2	2.6		
Air exchange rate for building and room (1/h)	Behavioral	Lognormal-n (truncated)	0.4187	0.88	0.001	0.999
Air release fraction	Behavioral	Triangular	0.000001	1	0.07	
Deposition velocity (m/s)	Physical	Loguniform	0.000003	0.0027		
Direct ingestion rate (g/h for volume source and 1/h for all other sources)	Behavioral	None recommended				
Humidity (g/m^3)	Physical, Behavioral	Uniform	6.5	13.1		
Indoor fraction	Behavioral	Empirical	Defined by cumulative probability (Table 7.6-1, Biwer, *et al.*, 2000)			
Receptor indirect ingestion rate (m^2/h)	Behavioral	Loguniform	0.000028	0.00029		
Receptor inhalation rate (m^3/d)	Metabolic, Behavioral	Triangular	12	46	33.6	
Room area (m^2)	Physical	Triangular	3	900	36	
Room height (m)	Physical	Triangular	2.4	9.1	3.7	
Shielding thickness (cm)	Physical, Behavioral	Triangular	0	30	0	
Source erosion rate, volume source (cm/d)	Physical, Behavioral	Triangular	0	0	0	
Source porosity	Physical	Uniform	0.04	0.25		
Source thickness, volume source (cm)	Physical	Triangular	2.5	30	15	
Time for source removal or source lifetime (d)	Physical, Behavioral	Triangular	1000	100000	10000	
Volumetric water content	Physical	Uniform	0.04	0.25		
Water fraction available for evaporation	Physical	Triangular	0.5	1	0.75	
Wet + dry zone thickness (cm)	Physical	Uniform	5	30		

Table C7.5 Distribution types for RESRAD-BUILD and RESRAD

Distribution	Input Variables			
Beta	A (minimum)	B (maximum)	p (shape factor)	q (shape factor)
Exponential Types				
Exponential	λ			
Bounded exponential	λ	A (minimum)	B (maximum)	
Truncated exponential	λ	Lower quantile value	Upper quantile value	
Gamma	α (shape factor)	β (scale factor)		
Inverse Gaussian	μ	λ		
Lognormal Types				
Lognormal	μ (mean)	error factor		
Lognormal-b	Value at 0.001 quantile	Value at 0.999 quantile		
Lognormal-n	Mean of underlying normal distribution	Standard dev. of underlying normal distribution		
Bounded lognormal	μ (mean)	Error factor	A (minimum)	B (maximum)
Bounded lognormal-n	Mean of underlying normal distribution	Standard dev. of underlying normal distribution	A (minimum)	B (maximum)
Truncated lognormal	μ (mean)	Error factor	Lower quantile value	Upper quantile value
Truncated lognormal-n	Mean of underlying normal distribution	Standard dev. of underlying normal distribution	Lower quantile value	Upper quantile value
Loguniform Types				
Loguniform	A (minimum)	B (maximum)		
Piecewise loguniform	Number of intervals	# observations per interval 1…	# observations per interval n	First point, end point sequence
Maximum Entropy	A (minimum)	B (maximum)	μ (mean)	
Normal Types				
Normal	μ (mean)	σ (standard deviation)		
Normal-b	Value at 0.001 quantile	Value at 0.999 quantile		
Bounded normal	μ (mean)	σ (standard deviation)	A (minimum)	B (maximum)
Truncated normal	μ (mean)	σ (standard deviation)	Lower quantile value	Upper quantile value
Pareto	α	β		
Triangular	a (minimum)	b (most likely)	c (maximum)	
Uniform Types				
Uniform	A (minimum)	B (maximum)		
Piecewise uniform	Number of intervals	# observations per interval 1…	# observations per interval n	First point, end point sequence
User Defined Types				
With linear interpolation (CDF input)	n (number of ordered pairs)	Ordered pair 1	Ordered pair 2 …	Ordered pair n
With logarithmic interpolation (CDF input)	n (number of ordered pairs)	Ordered pair 1	Ordered pair 2 …	Ordered pair n
With density function input	n (number of ordered pairs)	Ordered pair 1	Ordered pair 2 …	Ordered pair n
Weibull	α	β		

Table C7.6 Assigned Distribution Types and Distribution Statistical Parameters for RESRAD Parameters

Parameter	Classification	Assigned Distribution Type	Distribution's Statistical Parameters			
			1	2	3	4
Density of contaminated zone (g/cm^3)	Physical	Normal (truncated)	1.52	0.23	0.001	0.999
Density of cover material (g/cm^3)	Physical	Normal (truncated)	1.52	0.23	0.001	0.999
Density of saturated zone (g/m^3)	Physical	Normal (truncated)	1.52	0.23	0.001	0.999
Depth of roots (m)	Physical	Uniform	0.3	4		
Distribution coefficients (contaminated zone, unsaturated zones, and saturated zone) (cm^3/g)	Physical	Lognormal-n (truncated)	Radionuclide-specific (Table 3.9-1, Biwer, *et al.*, 2000)			
Saturated zone effective porosity	Physical	Normal (truncated)	0.355	0.0906	0.001	0.999
Saturated zone hydraulic conductivity (m/yr)	Physical	Lognormal-n (bounded)	2.3	2.11	0.004	9250
Saturated zone total porosity	Physical	Normal (truncated)	0.425	0.0867	0.001	0.999
Transfer factors for plants	Physical	Lognormal-n (truncated)	Element-specific (Table 6.2-1, Biwer, *et al.*, 2000)			
Unsaturated zone thickness (m)	Physical	Lognormal-n (bounded)	2.296	1.276	0.18	320
Aquatic food contaminated fraction	Behavioral, Physical	Triangular	0	1	0.39	
Bioaccumulation factors for fish [(pCi/kg)/(pCi/L)]	Physical	Lognormal-n	Element-specific (Table 6.8-1, Biwer, *et al.*, 2000)			
^{14}C evasion layer thickness in soil (m)	Physical	Triangular	0.2	0.6	0.3	
Contaminated zone b parameter	Physical	Lognormal-n (bounded)	1.06	0.66	0.5	30
Inhalation rate (m^3/yr)	Metabolic, Physical	Triangular	4380	13100	8400	
Contaminated zone erosion rate (m/yr)	Physical, Behavioral	Empirical	Defined by cumulative probability (Table 3.8-1, Biwer, *et al.*, 2000)			
Contaminated zone hydraulic conductivity (m/yr)	Physical	Lognormal-n (bounded)	2.3	2.11	0.004	9250
Contaminated zone total porosity	Physical	Normal (truncated)	0.425	0.0867	0.001	0.999
Cover depth (m)	Physical	None recommended				
Cover erosion rate (m/yr)	Physical, Behavioral	Empirical	Defined by cumulative probability (Table 3.8-1, Biwer, *et al.*, 2000)			
Depth of soil mixing layer (m)	Physical	Triangular	0	0.6	0.15	
Drinking water intake (L/yr)	Metabolic, Behavioral	Lognormal-n (truncated)	6.015	0.489	0.001	0.999
Evapotranspiration coefficient	Physical	Uniform	0.5	0.75		
External gamma shielding factor	Physical	Lognormal-n (bounded)	-1.3	0.59	0.044	1
Fruit, vegetables, and grain consumption (kg/yr)	Metabolic, Behavioral	Triangular	135	318	178	

Table C7.6 Assigned Distribution Types and Distribution Statistical Parameters for RESRAD Parameters (continued)

Parameter	Classification	Assigned Distribution Type	Distribution's Statistical Parameters			
			1	2	3	4
Indoor dust filtration factor	Physical, Behavioral	Uniform	0.15	0.95		
Mass loading for inhalation (µg/m^3)	Physical, Behavioral	Empirical	Defined by cumulative probability (Table 3.6-1, Biwer, *et al.*, 2000)			
Milk consumption (L/yr)	Metabolic, Behavioral	Triangular	60	200	102	
Precipitation rate (m/yr)	Physical	Empirical	Defined by cumulative probability (Table 4.1-1, Biwer, *et al.*, 2000)			
Runoff coefficient	Physical	Uniform	0.1	0.8		
Saturated zone b parameter	Physical	Lognormal-n (bounded)	1.06	0.66	0.5	30
Saturated zone hydraulic gradient	Physical	Lognormal-n (bounded)	-5.11	1.77	0	0.5
Soil ingestion rate (g/yr)	Metabolic, Behavioral	Triangular	0	36.5	18.3	
Transfer factors for meat [(pCi/kg)/(pCi/d)]	Physical	Lognormal-n (truncated)	Element-specific (Table 6.3-1, Biwer, *et al.*, 2000)			
Transfer factors for milk [(pCi/L)/(pCi/d)]	Physical	Lognormal-n (truncated)	Element-specific (Table 6.4-1, Biwer, *et al.*, 2000)			
Unsaturated zone density (g/cm^3)	Physical	Normal (truncated)	1.52	0.23	0.001	0.999
Unsaturated zone effective porosity	Physical	Normal (truncated)	0.355	0.0906	0.001	0.999
Unsaturated zone hydraulic conductivity (m/yr)	Physical	Lognormal-n (bounded)	2.3	2.11	0.004	9250
Unsaturated zone, soil-b parameter	Physical	Lognormal-n (bounded)	1.06	0.66	0.5	30
Unsaturated zone total porosity	Physical	Normal (truncated)	0.425	0.0867	0.001	0.999
Weathering removal constant (1/yr)	Physical	Triangular	5.1	84	18	
Well pumping rate (m^3/yr)	Behavioral, Physical	None recommended				
Well pump intake depth (below water table) (m)	Physical	Triangular	6	30	10	
Wet foliar interception fraction for leafy vegetables	Physical	Triangular	0.06	0.95	0.67	
Wet-weight crop yields for non-leafy vegetables (kg/m^2)	Physical	Lognormal-n (truncated)	0.56	0.48	0.001	0.999
Wind speed (m/s)	Physical	Lognormal-n (bounded)	1.445	0.2419	1	16
Humidity	Physical	Lognormal-n (truncated)	1.98	0.334	0.001	0.999
Indoor fraction	Behavioral	Empirical	Defined by cumulative probability (Table 7.6-1, Biwer, *et al.*, 2000)			

8.0 CRITERIA FOR TREATING UNCERTAINTY

8.1 Introduction

Uncertainty is inherent in all dose assessment calculations and must be considered in regulatory decision-making. In general, there are three primary sources of uncertainty in a dose assessment; (1) uncertainty in the models, (2) uncertainty in scenarios, and (3) uncertainty in the parameters (Bonano *et al.*, 1988, and Kozak *et al.*, 1991). As stated in Section 5.0, "Criteria to Establish Conceptual Models", models are simplifications of reality and, in general, several alternative models may be consistent with available data. Uncertainty in scenarios is the result of our lack of knowledge about the future of the site. Parameter uncertainty results from incomplete knowledge of the model coefficients.

The NRC's risk-informed approach to regulatory decision-making suggests that an assessment of uncertainty be included in estimating doses. Specifically, the Probabilistic Risk Assessment (PRA) Policy Statement (60 FR 42622, August 16, 1995) states, in part, "The use of PRA technology should be increased in all regulatory matters to the extent supported by the state of the art in PRA methods and data, and in a manner that complements the NRC's deterministic approach . . . " In the past, dose assessments in support of NRC decommissioning requirements have primarily included the use of deterministic analyses. The deterministic approach has the advantage of being simple to implement and easy to communicate to a nonspecialist audience. However, it has a significant drawback in not allowing consideration of the effects of unusual combinations of input parameters and by not providing information on uncertainty in the results, which would be helpful to the decision-maker. Furthermore, a deterministic analysis that had a high assurance of not being exceeded would have to rely on the use of pessimistic estimates of each parameter of the model, often leading to overly conservative evaluations. Even with the use of probabilistic analyses, it is generally recognized that not all sources of uncertainty can be considered in a dose assessment, nor need to be considered. The primary emphasis in uncertainty analysis should be to identify the important assumptions and parameter values that, when altered, could change the decision.

Sensitivity analysis performed in conjunction with the uncertainty analysis can be used to identify parameters and assumptions that have the largest effect on the result. Sensitivity analysis provides a tool for understanding and explaining the influence of these key assumptions and parameter values on the variability of the estimated dose.

8.2 Issues in Uncertainty and Sensitivity Analyses

Uncertainty analysis imparts more information to the decision-maker than deterministic analysis. It characterizes a range of potential doses and the likelihood that a particular dose will be exceeded.

An important issue in uncertainty and sensitivity analysis is that not all sources of uncertainty can be easily quantified. Of the three primary sources of uncertainty in dose assessment analyses, parameter uncertainty analysis is most mature. However, approaches for quantifying conceptual model and scenario uncertainty are less well-developed. Difficulties in predicting the characteristics of future society, especially those influencing exposure, can lead to large uncertainties. At most, one is able to assert that an acceptably complete suite of scenarios has been considered in the assessment (Flavelle, 1992). For these reasons, we make no attempt to quantify formally model or scenario uncertainty, although to a certain extent, these are captured in parameter uncertainty analyses. Choices of the conceptual model(s) and scenarios to be used for the site are discussed in Sections 4 and 5.

Uncertainty analyses frequently use the Monte Carlo method. Input variables for the models are selected randomly from probability distribution functions, which may be either independent or correlated to other input variable distributions. Critics of formal uncertainty analysis have often pointed out that limitations of knowledge about the nature and extent of correlation among variables fundamentally limit our ability to make meaningful statements about the degree of uncertainty in dose assessments (Smith *et al.*, 1992).

Because the results of an uncertainty analysis provide a distribution of doses, it must be recognized that some percentage of the calculated doses may exceed the regulatory limit. A key issue that must be addressed in the treatment of uncertainty is specifying how to interpret the results from an uncertainty analysis in the context of a deterministic regulatory limit. Agency practice has not been to require absolute assurance that the regulatory limit will be met, so regulatory compliance could be stated in terms of a metric of the distribution such as the mean, or a percentage of calculated doses allowed to exceed the limit. Even for a deterministic analysis, it is recognized that the reported dose is simply one of a range of possible doses that could be calculated for the site; therefore, there is still an issue of where this calculated dose should lie in terms of the unquantified spectrum of possible doses.

In summary, the key issues in addressing uncertainty are; (1) incorporating alternative conceptual models and scenarios to identify a complete suite of possibilities, (2) determining how to select appropriate parameter distribution and ranges, along with the associated correlation between parameters for the analysis, and (3) specifying the metric of the dose distribution to use in determining compliance with the dose limit.

8.3 Recommended Approach

8.3.1 Screening Analyses

Often the first step in evaluating site compliance will be a screening analysis. At preliminary stages of the evaluation, there may be little information available about the site. Therefore, the NRC screening approach is designed to ensure that there is high confidence that the dose will not be underestimated. As discussed in Sections 4 and 5, "Criteria for Modifying Pathways" and "Criteria to Establish Conceptual Models", the models and scenarios used in screening were selected to represent generic conditions and are intended to be "prudently conservative." The screening analysis assumes that all that is known about a site is the source term. Accordingly, the default parameters were selected to make it unlikely for the screening dose to exceed the dose that would be calculated using site-specific information.

The NRC published a screening table for building-surface contamination (63 FR 64132). The staff performed a Monte Carlo analysis, using the DandD code, with values of the input parameters sampled from wide ranges selected to represent the variability in those parameters across the United States. The default values of input parameters for the DandD code (*i.e.*, the values that the code would use without specification by the user) were then chosen from distributions of those parameters that would never cause the 90^{th} percentile of the output dose distribution from the Monte Carlo analysis to be exceeded for any radionuclide, as illustrated in

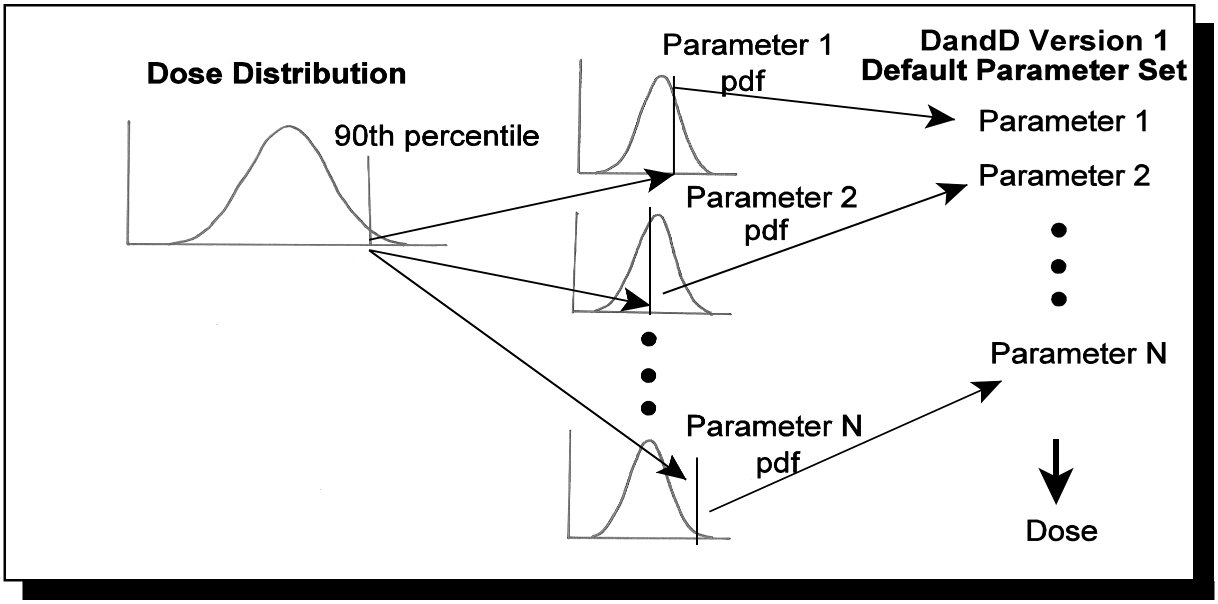

Figure C8.1 Treatment of parameter uncertainty in DandD Version 1.

Figure C8.1 (Beyeler *et al.*, 1999). Since DandD version 1.0 is a deterministic computer code, it is not necessary for the user to perform a Monte Carlo analysis for screening. The intent of the specification of default parameter values, scenario, and conceptual models in the DandD code was to ensure that there will be less than a 10 percent probability that the calculated dose using site-specific information will exceed the dose limit. Because the default parameters, scenarios, and conceptual models in DandD Version 1.0 are designed to provide high confidence that the dose will not be underestimated, an licensee using the code does not need to quantify the uncertainty in the dose analysis. The calculated results will be considered to represent a “prudently conservative” estimate of the dose (i.e., the calculated dose is likely an overestimation of the true dose). In many cases, however, the default parameter values chosen were highly conservative, making the outcome of the deterministic analysis overly stringent.

DandD Version 2.0 is designed to allow Monte Carlo analyses which give a distribution of doses as illustrated in Figure C8.2. To maintain consistency in approaches used for versions 1 and 2, and previously published screening tables, the 90th percentile of the dose distribution should be used to determine compliance with the LTR when used for screening analysis. Default parameter probability density functions have been incorporated into the code for screening analyses; therefore, for screening analyses, the license reviewer will only need to ensure that these aforementioned default parameters were used.

8.3.2 Site-Specific Analyses

8.3.2.1 Deterministic analysis

For site-specific analyses, the treatment of uncertainty in deterministic and probabilistic analyses should be handled differently. The NRC’s risk-informed approach to regulatory decision-making suggests that an assessment of uncertainty should be included in dose analyses. However, in some cases such analyses may not be needed (e.g. bounding type analyses). Because no information is provided on the uncertainty in bounding analyses, it is

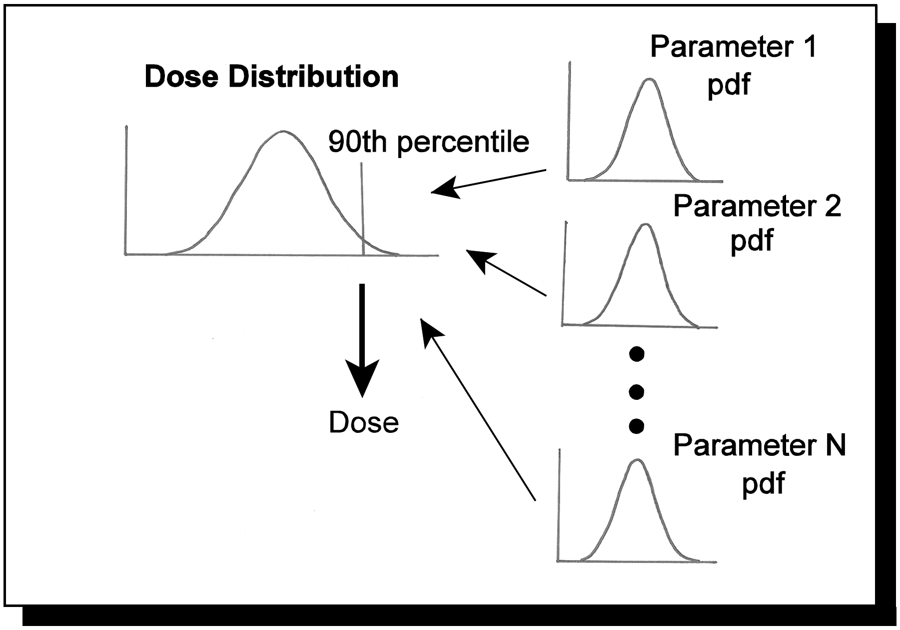

Figure C8.2 Treatment of parameter uncertainty in DandD Version 2.

important for the licensee to demonstrate that the single reported estimate of the peak dose is likely to be an overestimation

of the actual peak dose. Use of conservatism in only some aspects of the analysis may not necessarily result in a conservative estimate of the dose. Uncertainties in the conceptual model may be larger than uncertainties in parameters used in the analysis; therefore, use of conservative parameter values do not necessarily ensure a conservative estimate of the dose. To ensure that the results from a deterministic analysis are unlikely to underestimate the dose, it is recommended that the licensee use the approaches discussed in Sections 4 and 5 "Criteria for Modifying Pathways" and "Criteria to Establish Conceptual Models" for developing land-use scenarios and conceptual models. In addition, the licensee should use conservative values for key parameters. The approaches discussed below in Section 8.5, on performing sensitivity analyses should be used in identifying key parameters in the analysis.

8.3.2.2 Probabilistic analysis

Although bounding analyses are a good starting point for determining regulatory compliance, the demonstration that a single, deterministic result is bounding may be too difficult to prove. For site-specific probabilistic analysis, it is only necessary to demonstrate that the mean dose does not exceed the regulatory criterion. A single deterministic calculation using the mean values of parameters is unlikely to result in the mean dose.

Parameter uncertainty analysis provides a quantitative method for estimating the uncertainty in calculated doses, assuming the structure of the model is an adequate representation of the real world, and the exposure scenario is an appropriate reflection of potential future land-use at the site. Several methods have been developed for quantifying parameter uncertainty, including; (1) analytical methods, (2) Monte Carlo methods, (3) response surface methods, and (4) differential methods (Maheras and Kotecki, 1990). In addition, alternative approaches, such as the first-order reliability method, have recently been applied on a wide variety of environmental problems (Mirshra, 1998). Of these methods, the Monte Carlo methods are recommended because they are easy to implement and provide significant versatility.

Monte Carlo methods can be applied to either linear or nonlinear models, and analytical or numerical models. Input parameter uncertainties are represented as probability density functions. Parameter values randomly sampled from probability density functions are used as inputs to multiple runs or “realizations” of the model.

For probabilistic analyses, the peak of the plot of mean dose over time should be compared with the regulatory standard to determine compliance. Equation 8.1 shows how the mean dose as a function of time can be derived.

For N Monte Carlo Runs

$$Mean(t_i) = \frac{\sum_{k=1}^{N} Dose_k(t_i)}{N}$$

where : *Eq.C8.1*

$Mean(t_i) =$ *mean dose at time* t_i

$Dose_k(t_i) =$ *dose at time* t_i, *for run k*

$t_i =$ *time in years*

$i =$ *time steps (1 to 1000)*

Essentially, a mean dose is determined at each discrete time in the analysis. A plot is then made of these means over time. The mean dose provides the “best estimate” of dose at each discrete time. The overall peak of these best estimates is then used to determine compliance with the rule. Figure C8.3 shows how such a plot would be used to determine compliance with the regulations.

If the stated regulatory limits are exceeded, additional consideration should be given to allowing the proposed decommissioning action. The release-with-restrictions criteria assume that the land-use restrictions fail at some point. In some cases, especially with the use of durable institutional controls, it should be recognized that this will in general have a small likelihood of occurrence.

8.4 Input Parameter Distributions for Monte Carlo Analysis

A key aspect of any Monte Carlo analysis is defining the ranges and statistical distribution of parameters treated as uncertain in the analysis. It is important for the licensee to avoid assigning overly restrictive ranges that suggest an unwarranted precision in the state of knowledge. On the other hand, the specification of unreasonably large ranges may not account for what is known about a parameter and also may lead to "risk dilution". The distributions used in the analysis should characterize the degree of belief that the true but unknown value of a parameter lie within a specified range of values for that parameter.

Sensitivity results are generally less dependent on the actual distributions assigned to the input parameters than they are on the ranges chosen for the parameters. However, distributional assumptions can have a large impact on the dose distribution (Helton, 1993). Resources can often be used most effectively by performing a Monte Carlo analysis in an iterative manner. Initially, rather crude ranges and distribution assumptions can be used to determine which input variables dominate the behavior of the calculated dose. Often, most of the variation in the calculated dose is caused by a relatively small subset of input parameters. Once the most important input parameters are identified, resources can be concentrated on characterizing their uncertainty. This avoids spending a large effort characterizing the uncertainty in parameters that have little impact on the dose (Helton, 1993).

A reasonable strategy for assigning distributions for parameters used in Monte Carlo analyses is summarized below (Biwer, *et al.*, 2000):

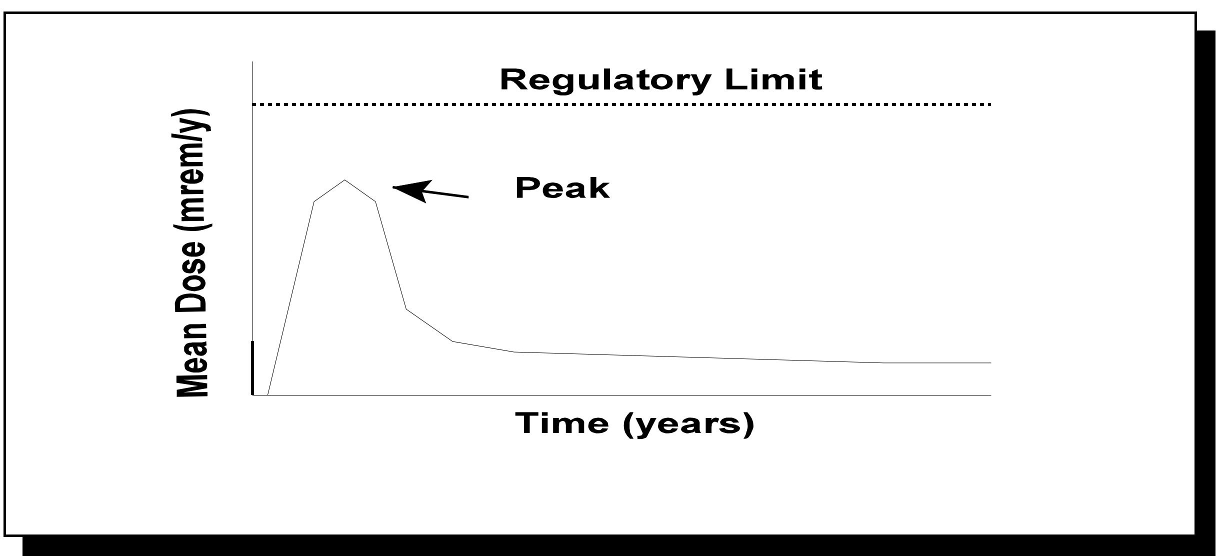

Figure C8.3 Application of Peak of the Mean Dose.

1. Select parameters to be assigned distributions - Not all parameters of the system under study require specification of a distribution. Those parameters that may well be distributed, but have little impact ultimately on the results, can be assigned constant values. Even if a parameter is known to have a significant effect on the results, its value may be specified at a constant value if it can be demonstrated that the choice leads to a conservative result.

2. Assign distributions for important parameters - the assignment of parameter distributions usually is a matter of the quantity of available data.

   Ample data available - Where there are ample data, empirical distributions of a parameter can be generated directly.

   Sufficient data available - Data plotted as histograms or in probability coordinates can be used to identify standard distributional forms (*e.g.*, normal, lognormal, and uniform).

   Parameters with some data - Where there are insufficient data to estimate the shape of an empirical distribution, data may be supplemented by other soft information. For example, if there were a mechanistic basis for assigning a given distribution, or if a distribution were well-known for the parameter, on a regional basis, this information could be used to estimate the likely shape of the distribution. Alternatively, the new data can be used to supplement a prior, non-site-specific parameter distribution (e.g., Bayesian updating).

   Parameters with insufficient information - If sufficient data are not available, but there were other kinds of data that imply the likely behavior of a parameter, then it may be possible to supplement the desired data indirectly. An example of such a procedure is the use of root uptake factors to infer distribution coefficients in soil (Baes, *et al.*, 1984). If only incomplete information is known about the parameter (e.g., its mean, or its range), and no correlations to other types of data are available, then the choice of the parameter distribution should reflect the uncertainty. The distribution should have the least-biased value, which is generally a wide distribution encompassing all the possible values. One procedure to assure that the distribution has the least bias is known as the "maximum entropy formalism," based on Shannon's informational entropy (Harr, 1987). This formalism allows the investigator to pick the distribution based on the kinds of information available on the parameter to assure that the result is least-biased; for example, if only the range of the data is known, a uniform distribution between the range is least-biased. Table C8.1 describes the maximum entropy solutions for several classes of data (Harr, 1987). Other, empirical sources of guidance for choosing parameter distributions can be found in several other references (IAEA, 1989; NCRP, 1996a).

3. Parameter correlations - Many of the parameters used in the probabilistic analyses will be correlated to other parameters. Some parameter distributions may in fact be used to derive other distributions (e.g., root uptake factors may be used to derive soil distribution coefficients). Also, correlations are expected on physical grounds, such as the relationship between hydraulic gradient and permeability. Where available, these correlation coefficients can then be used to generate correlated values of distributed parameters. This will help to avoid the situation where two correlated quantities are treated as uncorrelated, leading to unlikely combinations of parameters (e.g., high gradient and high-hydraulic conductivity). The effects of assumed minimum versus

assumed maximum levels of correlation can be investigated to evaluate the importance of including an explicit estimate of dependency between model parameters. In some cases, explicit modeling of the dependency between model parameters is possible, based on knowledge about the explicit mechanistic reasons for the dependencies. In general, it is more important to consider the effect of dependency when correlations are strong among the model's most sensitive parameters (see discussion below on identifying sensitive parameters); weak correlations between sensitive parameters and strong correlations among insensitive parameters will generally have very little impact on the overall calculated dose (NCRP, 1996a).

8.5 Sensitivity Analysis

Uncertainty and sensitivity analyses are closely linked, and ideally, they should be considered together. The primary aim of a sensitivity analysis is to identify the input parameters that are the major contributors to the variation or uncertainty in the calculated dose. Identifying these key parameters is essential for building a defensible case in support of the assessment. In other words, it is very important for the licensee to justify the value or range of values used in the assessment to represent these key parameters. Several of the more-popular sensitivity

Table C8.1 Maximum Entropy Probability Distributions. (Adapted from Harr, 1987)

Given Constraints on Data	Assigned Probability Density
Minimum and maximum only	Uniform
Expected value only	Exponential
Expected value and standard deviation	Normal
Expected value, standard deviation, minimum and maximum	Beta
Mean occurrence rate between arrival of independent events	Poisson

methods used in other performance assessments conducted at the NRC are presented below (NRC, 1999). It may be necessary for the licensee to use more than one approach in identifying the key parameters.

8.5.1 Deterministic Sensitivity Analysis

Two types of sensitivity analysis techniques are widely used: deterministic and Monte Carlo. The first, deterministic sensitivity analysis, calculates the change in the output result (i.e., peak dose) with respect to a small change in the independent variables, one at a time. The following formula illustrates the normalized sensitivity coefficient calculated from a deterministic analysis.

$$S_i = \left[\frac{\overline{X_i}}{d\left(\overline{X_i}\right)}\right]\left(\frac{\partial d}{\partial X_i}\right) \qquad \text{Eq. C8.2}$$

where:

$S_i =$ *sensitivity coefficient*

$\overline{X_i} =$ *baseline value of the* i^{th} *parameter*

$d(\overline{X}_i) =$ *peak dose for the baseline case*

$\partial d =$ *change in peak dose*

$\partial X_i =$ *change in* i^{th} *parameter*

Variable transformations, such as *normalization,* used in this example, are described further in Section 8.5.3.1.

The advantage of the deterministic technique is that it is unambiguous in terms of demonstrating a cause and effect for the given conceptual model. The disadvantages are that at least one evaluation of the model must be performed for every independent variable, and the sensitivity result applies only locally (i.e., for one location in the space of all of the independent variables).

8.5.2 Statistical Sensitivity Analysis techniques

The techniques used herein (except deterministic analysis) rely on the use of the Monte Carlo method for probabilistically determining system performance. Statistical analyses of Monte Carlo results starts with a large pool of realizations (hundreds to thousands). These techniques determine sensitivities of the dependent variable (dose) to changes in the independent variables. The main advantage of these techniques is that they allow sensitivity to be determined over wide ranges of the independent variables, as opposed to the deterministic techniques that apply to only one point within the ranges. The disadvantage of statistical techniques is that it is often difficult to extract useful information on sensitivity except for a small set of the most important variables, because smaller sensitivities are obscured. A compilation of some of the more-popular techniques for analyzing sensitivity from Monte Carlo results is presented below.

Usually, statistical sensitivity techniques have been applied to the set of peak doses drawn from the realizations. Sensitivity information from the ensemble of the peak doses provides useful information, and would be the correct approach if one were pursuing the "mean of the peaks" dose. However, this approach is not as meaningful for the "peak of the mean" dose. For the latter, the statistical techniques should be applied to the set of doses drawn from the Monte Carlo runs at the time of the peak of the mean dose.

8.5.2.1 Scatter Plot and Linear Regression on One Variable

In the scatter plot/single linear regression technique, peak TEDE is plotted versus each of the sampled input variables. This is often a good starting point for examining Monte Carlo results because strong relationships between peak dose and the independent variables are often obvious. Single linear regression of Monte Carlo results may fail to show unambiguous correlation since other sampled parameters that affect the output are varying at the same time.

8.5.2.2 Use of the t-Statistic to Determine Significance of Single Linear Regression Parameters

The t-test estimates the confidence that an estimated parameter value differs from another value. In this case, it is used to determine if there is a specified (e.g., 95-percent) confidence that the slope (m_i) of a single linear regression is different from zero (Benjamin and Cornell, 1970). $_i$

The t statistic of the slope of the regression line is defined:

$$t_i = m_i \sqrt{n \frac{S_{i,x}^2}{S^2}} \qquad \text{Eq. C8.3}$$

where

t_i — t-statistic for regression coefficient i
m_i — estimated value of regression coefficient (i.e., slope of the best-fit line for dose versus the independent variable i)
S — estimated standard deviation of dose
$S_{i,x}$ — estimated standard deviation of independent variable $\boldsymbol{x_i}$
n number of samples

When the number of realizations is large, the t distribution may be represented by the normal distribution. The critical value to ensure 95-percent confidence that m_i differs from zero under these conditions is 1.96. Equation C8.3 is used therefore to determine whether the absolute value of the t statistic for each independent variable is greater than 1.96. If not, then the hypothesis that the independent variable is significant is rejected.

8.5.2.3 Partial Rank Correlation

The partial rank correlation coefficient measures the strength of the relationship between variables after any confounding influences of other variables have been removed. The partial rank correlation coefficient between X_1 and Y, with the influence of X_2 removed, is given by:

$$\rho(X_1YX_2) = \frac{\rho_{X_1Y} - \left(\rho_{X_1X_2}\right)\left(\rho_{YX_2}\right)}{\left[\left(1-\rho_{X_1X_2}{}^2\right)\left(1-\rho_{YX_2}{}^2\right)\right]^{1/2}} \qquad \text{Eq C8.4}$$

where:
$\rho(X_1YX_2) \equiv$ *partial rank correlation coefficient between X_1 and Y, with the influence of X_2 removed*
$\rho_{X_1Y} \equiv$ *rank correlation coefficient between X_1 and Y*
$\rho_{X_1X_2} \equiv$ *rank correlation coefficient between X_1 and X_2*
$\rho_{YX_2} \equiv$ *rank correlation coefficient between Y and X_2*

8.5.2.4 Stepwise Multiple Linear Regression

Stepwise multiple linear regression (stepwise regression) determines the most influential independent variables on output uncertainty according to how much each reduces the residual sum of squares (RSS) (Helton, et al., 1991). The form of the regression equation is:

$$y = m_1x_1 + m_2x_2 + \ldots + m_nx_n + b \qquad \text{Eq. C8.5}$$

where
y — dependent variable (i.e., peak dose)
x_i — independent variables
i — regression coefficients
b — intercept

The variables may be the raw variables, transformed variables (e.g., logarithms), or ranks. The stepwise algorithm calculates the reduction in RSS for the independent variables in the order that gives the greatest reduction first. The regression coefficients m_i are the partial derivatives of the dependent variable with respect to each of the independent variables; therefore, m_i provides a measure of the relative change in output with respect to a change in the input variable, given that the other input variables are held constant.

8.5.2.5 Non-parametric tests

Non-parametric tests differ from regression and differential analyses in that they do not require fitting the data to prespecified functional form. The Kolmogorov-Smirnov (KS) test is one such test that determines whether a set of samples has been drawn from a specific distribution (Bowen and Bennett, 1988). It is used to determine whether an independent variable is important by comparing a subset of the independent variable composed of the values from the highest category (e.g., 10 percent) of the peak TEDE realizations to the theoretical distribution of that independent variable. If the distributions are equivalent, then peak TEDE is not sensitive to the variable in question. Conversely, if the distributions are different, then the variable in question does have an effect on peak TEDE.

8.5.3 Variable Transformations and Their Attributes

Demonstrating the relationship among input and output variables can be enhanced by transforming the variables. This section describes some common variable transformations used in sensitivity analysis.

8.5.3.1 Normalization

In normalization, the input variable x_i is transformed by dividing by its mean value (or another baseline such as the median, 90th percentile, etc.):

$$x_i^* = \frac{x_i}{\bar{x}} \qquad \text{Eq. C8.6}$$

Normalized variables are dimensionless and are scalar multiples of their baseline values. Dimensionless variables allow the comparison of sensitivities to other independent variables with different dimensions. Normalized variables are a natural outcome of sensitivity derived from regression of log-transformed variables. Such sensitivity measures describe only the relative change in the dependent variable (peak TEDE) to changes in the independent variables. Sensitivities calculated from normalized variables do not take into account the uncertainty in the independent variables.

8.5.3.2 Rank Transformation

Rank transformation, a dimensionless transform, replaces the value of a variable by its rank (i.e., the position in a list that has been sorted from largest to smallest values) (Iman and

Conover, 1979). Analyses with ranks tend to show a greater sensitivity than results with untransformed variables, and diminish the influence of the tails in highly skewed distributions.

8.5.3.3 Logarithmic Transformation

For situations in which input and output variables range over many orders of magnitude, it may be advantageous or even necessary to perform analyses on the logarithm of the variables instead of the variable values themselves. The log transformation is also valuable for creating regression equations, where the subprocesses of the model multiply each other to form the output variable. For the present situation, in which the dose calculation results from radionuclide releases from the waste form, transport through the geosphere, and uptake by humans, the processes are indeed largely multiplicative rather than additive. Log transforms therefore tend to give better fits to the Monte Carlo results than untransformed variables. The log transformation is generally used in conjunction with normalization.

8.5.3.4 Standardization

The independent and dependent variables can be standardized by subtracting the mean and dividing by the standard deviation, that is,

$$x_i^* = \frac{x_i - \bar{x}}{\sigma_x} \qquad \text{Eq. C8.7}$$

The advantage of standardization over normalization is that it inserts the approximate range of the variables into the sensitivity analyses. Therefore a variable that has a large per-unit sensitivity, but is well-known and has a narrow range, will have an increased sensitivity when standardized. Conversely, independent variables with wide ranges will show a reduced sensitivity when standardized.

Sensitivity measures based on standardized variables (standardized sensitivities) have the advantage of taking into account the uncertainty (in terms of the standard deviation) of the independent variable. This technique decreases the sensitivity if the range of the independent variable is large. Furthermore, the standardized sensitivities preserve the absolute values of peak TEDE since the derivatives are divided by the standard deviation for the entire set of calculations, rather than the mean peak TEDE at the evaluation point.

8.6 Conclusions

Sensitivity analyses should be used to identify parameters of the models and assumptions that have the largest effect on the results. These sensitivity results should be used to determine if more information on key parameters is warranted to make a convincing case for the acceptability of the site. The sensitivity techniques discussed here portray sensitivity in different ways, and all have their strengths and weaknesses. A useful way to use sensitivity results is to employ several different techniques, and then to determine if a common set of parameters regularly turns out to be important.

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APPENDIX D

ALARA ANALYSES

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In order to terminate a license, a licensee must demonstrate that the dose criteria in Subpart E of 10 CRR Part 20 have been met and must demonstrate whether it is feasible to further reduce the levels of residual radioactivity to levels below those necessary to meet the dose criteria (i.e., to levels that are "as low as is reasonably achievable" (ALARA). This Appendix describes methods acceptable to the Nuclear Regulatory Commission (NRC) staff for determining when it is feasible to further reduce the concentrations of residual radioactivity to below the concentrations necessary to meet the dose criteria. This appendix does not apply to, nor replace guidance for, operational ALARA programs. This guidance involves the same principle as the operational ALARA guidance:

> "Reasonably achievable" is judged by considering the state of technology and the economics of improvements in relation to all the benefits from these improvements. (However, a comprehensive consideration of risks and benefits will include risks from non-radiological hazards. An action taken to reduce radiation risks should not result in a significantly larger risk from other hazards.) NRC Regulatory Guide 8.8, Revision 3 (1978). [quotes in original]

In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the staff presumes, absent information to the contrary, that licensees or responsible parties that remediate building surfaces or soil to the generic screening levels do not need to demonstrate that these levels are ALARA. However, licensees or responsible parties should remediate their facility below these levels through practices such as good housekeeping. In addition, licensees or responsible parties should provide a description in the final status survey report of how these practices were employed to achieve the final activity levels.

In addition, if residual radioactivity cannot be detected, it may be assumed that it has been reduced to levels that are ALARA. Therefore, the licensee does not need to conduct an explicit analysis to meet the ALARA requirement.

Areas that have been released under then-existing requirements would not have to be reevaluated under 10 CFR 20.1401(c). According to 10 CFR 20.1401(c), the NRC would require additional clean-up following license termination only if it determines, based on new information, that the criteria of Subpart E were not met and that residual radioactivity remaining at the site could result in significant threat to public health and safety. Because ALARA represents an optimization technique below a dose criteria, it is not considered reasonable to reopen consideration of a previously released area, where radioactive materials were handled that meets the appropriate dose criterion.

In general, a method for determining whether levels of residual radioactivity are ALARA would have the following characteristics.

- **<u>The method is simple</u>**. The method for most licensee applications should be simple, because the effort needed for very sophisticated models cannot generally be justified.

In an ALARA analysis of a remediation action, the primary benefit (i.e., the collective radiation dose that will actually be averted in the future) is uncertain because future land uses, the number of people that will actually occupy a site, and the types of exposure scenarios are all uncertain. These uncertainties mean that the future collective dose cannot be known with precision. Because of the inherent limitation on the ability to precisely determine the future collective dose at a particular site, it is not useful to perform a complex analysis when a simple analysis can be appropriate. Licensees may use more complex or site-specific analyses if more appropriate for their specific situations (e.g., restricted release analyses, situations that include a number of unquantifiable benefits and costs).

- **The method is not biased and uses appropriate dose modeling to relate concentrations to dose**. The determination of ALARA should not be biased. This is different from demonstrating compliance with a dose limit. The analyses for dose assessments and surveys for compliance with the dose criteria described in this Standard Review Plan (SRP) include a reasonably conservative bias for demonstrating compliance. Unlike a demonstration of compliance, an ALARA analysis is an optimization technique that seeks the proper balance between costs and benefits below the dose limit. To achieve a proper balance, each factor in the ALARA analysis should be determined with as little bias as possible. If the ALARA analysis were intentionally biased, it would likely cause a misallocation of resources and could deprive society of the benefits from other uses of the resources. Thus, the ALARA analysis should provide an unbiased analysis of the remediation action, which can both avert future dose (a benefit to society) and cost money (a potential detriment because it can deprive future generations of the return on the investment of this money). Sections 1.1 and 1.2, respectively, discuss the methods that should be used in estimating benefits and detriments, or costs, including scenarios, models, and parameters for relating concentration to dose at a site. The Office of Management and Budget guidance to Federal agencies that implements the President's Executive Order 12866 "Regulatory Planning and Review," in Title 3 of the 1993 Compilation of the U.S. Code of Federal Regulations, January 1, 1994 (page 638), provides guidance on balancing benefits and detriments for analyzing the potential benefits of Federal regulations (Office of Management and Budget, "Economic Analysis of Federal Regulations under Executive Order 12866," January 11, 1996).

- **The method is usable as a planning tool for remediation**. Before starting a remediation action, the user should be able to determine generally what concentration of residual radioactivity would require a remediation action to meet the ALARA requirement. It would be inefficient if the user could not tell whether the area would pass the ALARA test until after the remediation. Establishing ALARA post-remediation would also likely result in it being less likely for a licensee to remediate below the dose limit(s) because of the additional manpower start-up costs associated with doing additional remediation.

- **As much as possible, the method uses the results of surveys conducted for other purposes**. The demonstration that the ALARA requirement has been met should not require surveys beyond those already performed for other purposes, such as the characterization survey and the final status survey. It would be inefficient (and unnecessary) to collect additional sets of measurements to demonstrate that remediation actions were taken wherever appropriate to meet the ALARA requirement if measurements undertaken for other purposes could be used.

1.0 ALARA Analyses

Subpart E of 10 CFR Part 20 contains specific requirements for a demonstration that residual radioactivity has been reduced to a level that is ALARA (10 CFR 20.1402, 20.1403(a), 20.1403(e), and 20.1404(a)(3)). A simplified method for demonstrating compliance with the ALARA requirement is described below. Licensees may use more complex or site-specific analyses if more appropriate for their specific situation. In general, more complex analyses will follow the general concepts presented herein. Evaluation of more complex analyses will be handled on a case-by-case basis and early involvement of the appropriate regulatory agencies and members of the public is suggested.

Sometimes it is very difficult or impossible to place a monetary value on an impact. A best effort should be made to assign a monetary value to the impact, because there may be no other way to compare benefits to costs. However, there may be situations for which a credible monetary value cannot be developed. In these situations, a qualitative treatment may be the most appropriate. Qualitative analyses will be evaluated on their merits on a case-by-case basis.

The simplified method presented here is to estimate when a remediation action is cost-effective using generalized estimates for the remedial action. If the desired beneficial effects ("benefits") from the remediation action are greater than the undesirable effects or "costs" of the action, the remediation action being evaluated is cost-effective and should be performed. Conversely, if the benefits are less than the costs, the levels of residual radioactivity are already ALARA without taking the remediation action. An example of various benefits and costs are listed in Table D1. Other than Collective Dose Averted, the additional benefits listed tend to only be important in comparisons between alternatives that address whether restricted release can be pursued by the licensee. The value of any benefit or cost can be negative in some cases.

Table D1. Possible Benefits and Costs Related to Decommissioning

Possible Benefits	Possible Costs
Collective Dose Averted Regulatory Costs Avoided Changes in Land Values Esthetics Reduction in Public Opposition	Remediation Costs Additional Occupational/Public Dose Occupational Non-radiological Risks Transportation Direct Costs and Implied Risks Environmental Impacts Loss of Economic Use of Site/Facility

In order to compare the benefits and costs of a remediation action, it is necessary to use a comparable unit of measure. The unit of measure used here is the dollar; all benefits and costs are given a monetary value, if possible. Benefits and costs are calculated as described in Sections 1.1 and 1.2 below.

The method should be applied during remediation planning, prior to the start of remediation, but after some or all of the characterization work is done. The method should be used only to determine whether and where particular remediation actions should be taken to meet the ALARA requirement.

If the licensee has already decided to perform a remediation action, there is no need to analyze whether the action was necessary to meet the ALARA requirement. The analysis described in this section is needed only to justify not taking a remediation action. For example, if a licensee plans to wash room surfaces (either to meet the dose limit or as a good practice procedure), there is no need to analyze whether the remediation action of washing is necessary to meet the ALARA requirement.

1.1 Calculation of Benefits

Collective Dose Averted

In the simplest form of the analysis, the only benefit estimated from a reduction in the level of residual radioactivity is the monetary value of the collective averted dose to future occupants of the site. For buildings, the collective averted dose from residual radioactivity should be based on some form of the building occupancy scenario. For land, the averted dose will generally be based on the resident farmer scenario. In general, the ALARA analysis should use the same critical group scenario that is used for the compliance calculation. Additional considerations related to groundwater contamination are discussed in Section 1.6.

The benefit from collective averted dose, B_{AD}, is calculated by determining the present worth of the future collective averted dose and multiplying it by a factor to convert the dose to monetary value:

$$B_{AD} = \$2000 \times PW(AD_{collective}) \qquad \textbf{(D1)}$$

where B_{AD} = benefit from averted dose for a remediation action, in \$
$2000 = value in dollars of a person-rem averted (see NUREG/BR0058 "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Revision 2, November 1995)
$PW(AD_{collective})$ = present worth of future collective averted dose

An acceptable value for collective dose is $2000 per person-rem averted, discounted for dose averted in the future (See Section 4.3.3 of "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," NUREG/BR-0058, Revision 2, November 1995.). For doses averted within the first 100 years, a discount rate of 7percent should be used. For doses averted beyond 100 years, a 3 percent discount rate should be used.

The present worth of the future collective averted dose can be estimated from the equation below, for relatively simple situations:

$$PW(AD_{collective}) = P_D \times A \times 0.025 \times F \times \frac{Conc}{DCGL_W} \times \frac{1 - e^{-(r+\lambda)N}}{r+\lambda} \qquad \textbf{(D2)}$$

P_D	=	population density for the critical group scenario in people/m^2;
A	=	area being evaluated in square meters (m^2)
0.025	=	annual dose to an average member of the critical group from residual radioactivity at the Derived Concentration Guideline Level ($DCGL_W$) concentration in rems/yr;
F	=	fraction of the residual radioactivity removed by the remediation action. *F* may be considered to be the removable fraction for the remediation action being evaluated;
Conc	=	average concentration of residual radioactivity in the area being evaluated in units of activity per unit area for buildings or activity per unit volume for soils;
$DCGL_W$	=	derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 0.25 mSv/yr (25 mrem/yr) to the average member of the critical group, in the same units as *"Conc"*
r	=	monetary discount rate in units of yr^{-1};
λ	=	radiological decay constant for the radionuclide in units of yr^{-1}; and
N	=	number of years over which the collective dose will be calculated.

The present worth of the benefit calculated by Equation 2, above, assumes that the peak dose occurs in the first year. This is almost always true for the building occupancy scenario, but not always true for the residential scenario where the peak dose can occur in later years. When the peak dose occurs in later years, Equation 2 would overestimate the benefit. The licensee may perform a more exact calculation that avoids this overestimation of the benefit of remediation by calculating the dose during each year of the evaluation period and then calculating the present worth of each year's dose. A detailed derivation of Equation 2 and some of the other equations are in the Annex to this Appendix.

The $DCGL_W$ used should be the same as the $DCGL_W$ used to show compliance with the 0.25 mSv/yr (25 mrem/yr) dose limit. The population density, P_D, should be based on the dose scenario used to demonstrate compliance with the dose limit. Thus, for buildings, the licensee should estimate P_D for the building occupancy scenario. For soil, the P_D should be based on the residential scenario. The factor at the far right of the equation, which includes the exponential terms, accounts for both the present worth of the monetary value and radiological decay.

If more than one radionuclide is present, the total benefit from collective averted dose, B_{AD}, is the sum of the collective averted dose for each radionuclide. When multiple radionuclides have a fixed concentration (i.e., secular equilibrium), residual radioactivity below the dose criteria is normally demonstrated by measuring one radionuclide and comparing its concentration to a $DCGL_W$ that has been calculated to account for the dose from the other radionuclides. In this case, the adjusted $DCGL_W$ may be used with the concentration of the radionuclide being measured. The other case is when the ratio of the radionuclide concentrations is not fixed and varies from location to location within a survey unit; this benefit is the sum of the collective averted dose from each.

Regulatory Costs Avoided

This benefit usually manifests in ALARA analyses of restricted release versus unrestricted release decommissioning goals. By releasing the site with no restrictions, the licensee will avoid the various costs associated with restricted release. These can include: (1) additional licensing fees to develop an Environmental Impact Statement, (2) financial assurance related to both the decommissioning fund [10 CFR 20.1403(c)] and the site restrictions [10 CFR 20.1403(d)(1)(ii)], (3) costs (including NRC-related) associated with public meetings or the community review committee [10 CFR 20.1403(d)(2)], and (4) future liability. When evaluating the ability of a licensee's proposal for restricted release according to 10 CFR 20.1403(a), avoiding these costs should be included in the benefits of the unrestricted release decommissioning alternative. These should not be included as costs related to the restricted release (see 1.2).

Changes in Land Values

The licensee should account for any expected change in the value of the site or facility caused by the different decommissioning options. This may be difficult to quantify.

Esthetics/Reduction in Public Opposition

These, too, can be very difficult to quantify. The licensee may wish to evaluate the effect of its decommissioning options with respect to the overall esthetics (including the decommissioning activities themselves) of the site and surrounding area. Another factor the licensee may wish to consider is the potential reduction in opposition, if there is any, to the decommissioning activities/goal the license is attempting to propose.

1.2 Calculation of Costs

The licensee should evaluate the costs of the remediation actions being evaluated. When doing a fairly simple evaluation, the costs generally include the monetary costs of: (1) the remediation action being evaluated, (2) transportation and disposal of the waste generated by the action, (3) workplace accidents that occur because of the remediation action, (4) traffic fatalities resulting from transporting the waste generated by the action, (5) doses received by workers performing the remediation action, and (6) doses to the public from excavation, transport, and disposal of the waste. Other costs that are appropriate for the specific case may also be included.

The total cost, $Cost_T$, which is balanced against the benefits, has several components.

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other} \quad \textbf{(D3)}$$

where $Cost_R$ = monetary cost of the remediation action (may include "mobilization" costs);
$Cost_{WD}$ = monetary cost for transport and disposal of the waste generated by the action;
$Cost_{ACC}$ = monetary cost of worker accidents during the remediation action;
$Cost_{TF}$ = monetary cost of traffic fatalities during transporting of the waste;
$Cost_{WDose}$ = monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility;
$Cost_{PDose}$ = monetary cost of the dose to the public from excavation, transport, and disposal of the waste;
$Cost_{other}$ = other costs as appropriate for the particular situation.

All the costs described below do not necessarily have to be calculated. For example, if one or two of the costs can be shown to be in excess of the benefit, the remediation action has been shown to be unnecessary without calculating the other costs. Additionally, in some comparisons between alternate decommissioning options, some of these costs may in fact be negative (i.e., the alternative will cost less than the preferred option).

Remedial Action Costs

Calculation of the incremental remedial action costs include the standard manpower and mechanical costs. The licensee can account for any additional licensing fees from NRC (e.g., if the option to meet the ALARA goal requires another year of remediation). Lower concentrations may change sampling/survey requirements. Increased survey costs can be considered in the remedial action but note that this is the incremental costs of surveying below the dose limit. Survey costs related to evaluating compliance at the dose limit are not part of the ALARA analysis.

Transport and Disposal of the Waste

The cost of waste transport and disposal, $Cost_{WD}$, may be evaluated according to the following equation.

$$Cost_{WD} = V_A \text{ x } Cost_V \quad \textbf{(D4)}$$

Where V_A = volume of waste produced, remediated in units of m^3; and

$Cost_V$ = cost of waste disposal per unit volume, including transportation cost, in units of $/m^3

Non-Radiological Risks

The cost of nonradiological workplace accidents, $Cost_{ACC}$, may be evaluated using the equation below.

$$Cost_{ACC} = \$3{,}000{,}000 \, x F_W x T_A \tag{D5}$$

where $3,000,000 = monetary value of a fatality equivalent to $2000/person-rem (see, pages 11-12 of "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy," NUREG-1530, December 1995);
F_W = workplace fatality rate in fatalities/hour worked;
T_A = worker time required for remediation in units of worker-hours.

Transportation Risks

The cost of traffic fatalities incurred during the transportation of waste, $Cost_{TF}$, may be calculated similar to the equation below.

$$Cost_{TF} = \$3{,}000{,}000 \times \left(V_A / V_{SHIP} \right) \times F_T \times D_T \tag{D6}$$

where V_A = volume of waste produced in units of m^3
F_T = fatality rate per truck-kilometer traveled in units of fatalities/truck-km
D_T = distance traveled in km
V_{SHIP} = volume of a truck shipment in m^3

The actual parameters should depend on the site's planned method of waste transport. Some facilities may consider a mix of trucking and rail transport to get the waste to the disposal site. In these cases, the cost would be equivalent to the total fatalities likely from the rail transport and the limited trucking, not just the trucking alone.

Worker Dose Estimates

The cost of the remediation worker dose, $Cost_{WDose}$, can be calculated as shown in the following equation:

$$Cost_{WDose} = \$2000 \times D_R \times T \tag{D7}$$

where D_R = total effective dose equivalent rate to remediation workers in units of rems/hr;
T = time worked (site labor) to remediate the area in units of person-hour.

The cost of worker dose usually should not be discounted because the dose is all incurred close to the time of license termination.

Loss of Economic Use of Property

A cost in the “other” category could include the fair market rental value or economic use for the site during the time the additional remediation work is being performed. These costs are usually associated with locations such as laboratories, hospital rooms, and industrial sites, etc. This cost may be added to the costs in Equation 3.

Environmental Impacts

Another cost that could fall into the other category would be a remediation action that may damage an ecologically valuable area or cause some other adverse environmental impact. These impacts should be included as costs of the remediation action.

Default Parameters

For performing these calculations, acceptable values for some of the parameters are shown in Table D2.

Table D2. Acceptable Parameter Values for Use in ALARA Analyses.

Parameter	Value	Reference and comments
Workplace accident fatality rate, F_W	4.2×10^{-8}/hr	NUREG-1496 (“Final Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities,” NUREG-1496, July 1997 Volume 2, Appendix B, Table A.1
Transportation fatal accident rate, F_T	Trucks: 3.8×10^{-8}/km	NUREG-1496, Volume 2, Appendix B, Table A.1
$/person-rem	$2000	NUREG/BR-0058
Monetary discount rate, *r*	0.07/yr for the first 100 years and 0.03/yr thereafter, or 0.07 for buildings and 0.03 for soil	NUREG/BR-0058
Number of years of exposure, *N*	Buildings: 70 yr soil: 1000 yr	NUREG-1496, Volume 2, Appendix B, Table A.1

Parameter	Value	Reference and comments
Population density, P_D	Building: 0.09 person/m^2 land: 0.0004 person/m^2	NUREG-1496, Volume 2, Appendix B, Table A.1
Excavation, monitoring, packaging, and handling soil	1.62 person-hours/m^3 of soil	NUREG-1496, Volume 2, Appendix B, Table A.1
Waste shipment volume, V_{SHIP}	truck: 13.6 m^3/shipment	NUREG-1496, Volume 2, Appendix B, Table A.1

1.3 Residual Radioactivity Levels that Are ALARA

The residual radioactivity level that is ALARA is the concentration, *Conc,* at which the benefit from removal equals the cost of removal. If the total cost, $Cost_{T,}$ is set equal to the present worth of the collective dose averted in Equation 2, the ratio of the concentration, *Conc,* to the $DCGL_W$ can be determined (derivation shown in the Annex to Appendix D).

$$\frac{Conc}{DCGL_W} = \frac{Cost_T}{\$2000 \times P_D \times 0.025 \times F \times A} \times \frac{r + \lambda}{1 - e^{-(r + \lambda)N}} \qquad \textbf{(D8)}$$

All the terms in Equation 8 are as defined previously.

If a licensee is considering restricting use of its site, it should refer to Section 1.7 of this appendix, which describes additional cost and benefit considerations that should be included. This derivation only explicitly considers the benefits related to reduction in collective dose. The numerical value of the other benefits (if not dose-related) could be subtracted from the total cost.

Since P_D, N, and r are constants that have generic values for all locations on the site, the licensee only needs to determine the total cost, $Cost_T$, and the effectiveness, F, for a specific remediation action. If the concentration at a location exceeds *Conc*, it will be cost effective to remediate the location by a method whose total cost is $Cost_T$. Note that the concentration, *Conc,* that is ALARA can be higher or lower (more or less stringent) than the $DCGL_W$, although licensees must meet the $DCGL_W$.

1.4 Examples of Calculations

Example 1: Washing Building Surfaces

This example considers a building with cesium-137 residual radioactivity (λ = 0.023/yr). The remediation action to be considered is washing a floor of 100 m^2 area. The licensee estimates that this will cost \$400 and will remove 20 percent (F = 0.2) of the residual radioactivity. For buildings, generic parameters are: P_D = 0.09 person/m^2, r = 0.07/yr, and N = 70 years. Using these values in Equation 8:

$$\frac{Conc}{DCGL_W} = \frac{\$400}{\$2000 \times 0.2 \times 0.025 \times 0.09 \times 100\ m^2} \times \frac{0.07 + 0.023}{1 - e^{-(0.07 + 0.023)70}} \qquad \textbf{(D9)}$$

$$\frac{Conc}{DCGL_W} = 0.41 \qquad \textbf{(D10)}$$

To meet the ALARA requirement, the floor should be washed if the average concentration exceeds about 41 percent of the $DCGL_W$. This is more stringent than the dose limit. This calculation shows that washing building surfaces is often necessary to meet the ALARA requirement. If the surfaces will be washed, there is no need for the licensee to perform the ALARA evaluation or to submit the evaluation to the NRC. If the licensee decided not to wash the building surfaces, the licensee could submit this evaluation and demonstrate in the final status survey that all surfaces have a concentration below 41 percent of the $DCGL_W$.

Example 2: Scabbling Concrete in a Building

This example is the same as above except that it evaluates use of a scabbling tool that removes the top 1/8 inch of concrete. The licensee estimates the total cost of the scabbling will be $5000 for the 100 m^2 floor and estimates that it will remove all the residual radioactivity so that F = 1. Using these values in Equation 8 gives:

$$\frac{Conc}{DCGL_W} = \frac{\$5000}{\$2000 \times 1 \times 0.025 \times 0.09 \times 100\ m^2} \times \frac{0.07 + 0.023}{1 - e^{-(0.07 + 0.023)70}} \qquad \textbf{(D11)}$$

$$\frac{Conc}{DCGL_W} = 0.97 \qquad \textbf{(D12)}$$

The licensee could decide to scabble depending on the concentrations present. In lieu of scabbling, the licensee could provide this analysis and demonstrate that the floor concentration is less than 0.97 $DCGL_W$.

Example 3: Removing Surface Soil

In this example, soil with an area of 1000 m^2 is found to contain radium-226 (λ = 0.000247/yr) residual radioactivity to a depth of 15 centimeters (cm). The licensee estimates that the cost of removing the soil (F = 1) will be \$100,000. For soil, the generic parameters are P_D = 0.0004 person/m^2, r = 0.03/yr, and N = 1000 yr. Using these values in Equation 8 gives:

$$\frac{Conc}{DCGL_W} = \frac{\$100{,}000}{\$2000 \times 1 \times 0.025 \times 0.0004 \times 1000\ m^2} \times \frac{0.03 + 0.000247}{1 - e^{-(0.03\ +\ 0.000247)1000}} \qquad \textbf{(D13)}$$

$$\frac{Conc}{DCGL_W} = 151 \qquad \textbf{(D14)}$$

Thus, meeting the dose limit would be limiting by a considerable margin. Based on these results, it would rarely be necessary to ship soil to a waste disposal facility to meet the ALARA requirement. The licensee could use this evaluation to justify not removing soil.

The advantage of the approach shown in these examples is that it allows the user to estimate a concentration at which a remediation action will be cost-effective prior to starting remediation and prior to planning the final status survey. Thus, it is a useful planning tool that lets the user determine which remediation actions will be needed to meet the ALARA requirement.

1.5 When Mathematical Analyses Are Not Necessary

In certain circumstances, the results of an ALARA analysis are known on a generic basis and an analysis is not necessary. For residual radioactivity in soil at sites that will have unrestricted release, generic analyses (see NUREG-1496, the examples in this appendix, and other similar examples) show that shipping soil to a low-level waste disposal facility is unlikely to be cost effective for unrestricted release, largely because of the high costs of waste disposal. Therefore shipping soil to a low-level waste disposal facility generally does not have to be evaluated for unrestricted release. In addition, licensees that have remediated surface soil and surfaces to the default screening criteria developed by NRC, have remediated soil such that it meets the unrestricted use criteria in 10 CFR 20.1402 or if no residual radioactivity distinguishable from background will be left at the site would not be required to demonstrate that these levels are ALARA.

Removal of loose residual radioactivity from buildings is almost always cost- effective except when very small quantities of radioactivity are involved. Therefore, loose residual radioactivity normally should be removed, and if it is removed, the analysis would not be needed.

1.6 Additional Considerations for Residual Radioactivity in Groundwater

The method described above is adequate for most situations and has minimal cost for analyses. However, other factors, as described below, should be included if the site will be released if it has residual radioactivity from site operations in groundwater.

If there is residual radioactivity from site operations in groundwater, it may be necessary to calculate the collective dose from consumption of the groundwater. Default or generic groundwater models typically assume that potable aquifers have small volumes and cannot supply large populations. When this is the case, dose calculations for the site critical group will adequately represent the collective dose from groundwater. However, when site-specific groundwater modeling is used, and the residual radioactivity is diluted in an aquifer of large volume and there is also an "existing population deriving its drinking water from a downstream supply using a downstream supply" (see page 39075 of "Radiological Criteria for License Termination," Final Rule, *Federal Register,* Volume 62, 62 FR 39058, July 21, 1997), the collective dose for that population should be included in the ALARA calculation. The possibility of reducing the collective dose by remediation should be one of the items evaluated as one of the benefits, even if remediation would not affect the critical group's doses significantly. Another consideration for groundwater residual radioactivity would be any potential costs incurred by other entities, such as a public water supply utility, to meet the requirements of the Safe Water Drinking Act, if the licensee's residual radioactivity levels would potentially lead to concentrations at the wellhead that would exceed the U.S. Environmental Protection Agency's Maximum Contaminant Levels.

2.0 Determination of "Net Public or Environmental Harm"

Subpart E, 10 CFR 20.1403(a) and 10 CFR 20.1403(e)(2)(I) address circumstances in which a licensee would be required to demonstrate that further remediation would cause net public or environmental harm. The calculation to demonstrate net public or environmental harm is a special case of the general ALARA calculation described above that compares the benefits in dose reduction to the cost of doses, injuries, and fatalities incurred. The calculation does not consider the monetary costs for performing further remediation, $Cost_{R,}$ or the costs of waste disposal, $Cost_{WD}$. Thus, if the benefit from averted dose B_{AD} is less than the sum of the costs of workplace accidents, $Cost_{ACC}$, the costs of transportation fatalities, $Cost_{TF}$, the costs of remediation worker dose, $Cost_{WDose}$, and the costs of any environmental degradation, $Cost_{ED}$, then there is net public or environmental harm. Thus, there is net public or environmental harm if:

$$\text{Net harm if} \quad B_{AD} < Cost_{ACC} + Cost_{TR} + Cost_{WDose} + Cost_{ED} \qquad \textbf{(D15)}$$

In some cases it will be very difficult to assign a credible monetary value to environmental degradation. For example, environmental harm could be caused by an action such as remediation of a wetlands area. There may be no way to assign a monetary value to this action. In these cases it is acceptable to use qualitative arguments, which will be evaluated on a case-by-case basis.

3.0 Demonstration of "Not Technically Achievable"

Subpart E, 10 CFR 20.1403(e)(2)(I) addresses circumstances in which a licensee would be required to demonstrate that further reductions in residual radioactivity are not technically achievable. Remediation of residual radioactivity is almost always technically achievable even if not economically feasible. This provision allows for special cases that may not be foreseeable; thus, specific guidance on this provision cannot be provided. Instead, NRC will evaluate licensee submittals on a case-by-case basis.

4.0 Demonstration of "Prohibitively Expensive"

Subpart E, 10 CFR 20.1403(e)(2) addresses circumstances in which a licensee would be required to demonstrate that further reductions in residual radioactivity would be prohibitively expensive. This can be demonstrated by an analysis like the ALARA analysis described above, but using a value of $20,000 per person-rem when calculating the value of the averted dose. This value reflects the NRC's statement in the final rule on radiological criteria for license termination that the NRC believes it is appropriate to consider that a remediation would be prohibitively expensive if the cost to avert dose were an order of magnitude more expensive than the cost recommended by the NRC for an ALARA analysis (see page 39071 of "Radiological Criteria for License Termination," Final Rule, *Federal Register,* Volume 62, 62 FR 39058, July 21, 1997). However, the NRC also stated that ". . . a lower factor may be appropriate in specific situations when the licensee could become financially incapable of carrying out decommissioning safely." Thus, values lower than $20,000 per person-rem may be used when remediation actions based on $20,000 per person-rem could cause the licensee to become financially incapable of carrying out the decommissioning safely.

Derivation of Equation 8 To Calculate the Concentration of Residual Radioactivity that Is ALARA

The ALARA analysis compares the monetary value of the desirable effects (benefits) of a remediation action (e.g., the monetary benefit of collective averted dose) with the monetary value of the undesirable effects (e.g., the costs of waste disposal). If the benefits of a remediation action would exceed the costs, the remediation action should be taken to meet the ALARA requirement.

$$\textit{If benefits} > \textit{costs}, \quad \textit{the remediation action should be taken} \tag{1}$$

The primary benefit from a remediation action is the collective dose averted in the future, i.e., the sum over time of the annual doses received by the exposed population. Assume:

1. A site has an area with residual radioactivity at concentration, *Conc*.
2. The concentration equivalent to 25 mrem (0.25 mSv)/yr ($DCGL_W$) for the site has been determined (for soil or for building surfaces, as appropriate).
3. The residual radioactivity at a site has been adequately characterized so that the effectiveness of a remediation action can be estimated in terms of the fraction F of the residual radioactivity that the action will remove.
4. The peak dose rate occurs at time 0 and decreases thereafter by radiological decay.

The derived concentration guideline ($DCGL_W$) is the concentration of residual radioactivity that would result in a total effective dose equivalent to an average member of the critical group of 0.25 mSv (25 mrem)/yr. Acceptable methods of calculating the $DCGL_W$ are discussed in Regulatory Position 1. Therefore, the annual dose D to the average member of the critical group from residual radioactivity at concentration *Conc* is:

$$D = 0.025 \ rem/yr \times \frac{Conc}{DCGL_W} \tag{2}$$

If a remediation action would remove a fraction, F, of the residual radioactivity present, the annual averted dose to the individual, $AD_{individual}$, is:

$$AD_{individual} \ (rem/yr/person) = F \times 0.025 \ rem/yr \times \frac{Conc}{DCGL_W} \tag{3}$$

The annual collective averted dose, $AD_{collective}$, can be calculated by multiplying the individual averted dose, $AD_{individual}$, by the number of people expected to occupy the area, A, containing the residual radioactivity. The number of people in the area containing the residual radioactivity is the area, A, times the population density, P_D, for the site.

Thus:

$$AD_{collective} = F \times 0.025 rem/yr \times \frac{Conc}{DCGL_W} \times A \times P_D \tag{4}$$

The annual monetary benefit rate at time 0, B_0, from the averted collective dose in dollars per year can be calculated by multiplying the annual collective averted dose, $AD_{collective,}$ by \$2000/person-rem (\$200,000/person-sievert) (Reference A1):

$$B_0 = \$2000 \times F \times 0.025\ rem/yr\ \frac{Conc}{DCGL_W} \times A \times P_D \tag{5}$$

The total monetary benefit of averted doses can be calculated by integrating the annual benefit over the exposure time in years, considering both the present worth of future benefits and radiological decay. It is OMB and NRC policy to use the present worth of both benefits and costs that occur in the future (References A1 and A2).

The equation for the present worth, $PW_{B,}$ of a series of constant future annual benefits, B (in dollars per year), for N years at a monetary discount rate of r (per year) using continuous compounding is:

$$PW_B = B \times \frac{e^{rN} - 1}{r\ e^{rN}} \tag{6}$$

The continuous compounding form of the present worth equation is used because it permits an easy formulation that includes radiological decay. If the annual benefit rate, *B,* is not constant but is decreasing from an original rate, $B_{0,}$ because of radiological decay, the radiological decay rate acts like an additional discount rate that can be added to the monetary discount rate of decrease so that the present worth of the annual benefits PW_B becomes:

$$PW_B = B_0 \times \frac{e^{(r+\lambda)N} - 1}{(r + \lambda)\ e^{(r+\lambda)N}} \tag{7}$$

Dividing the numerator and denominator of the right hand term by $e^{(r+\lambda)N}$ yields:

$$PW_B = B_0 \times \frac{1 - e^{-(r+\lambda)N}}{r + \lambda} \tag{8}$$

As $N \rightarrow \infty$, Equation 8 has the limit:

$$PW_B = B_0 \times \frac{1}{r + \lambda} \tag{9}$$

When the discount rate, *r,* is zero and the radiological decay rate is very small so that $r + \lambda \rightarrow 0$, and Equation 8 has the limit:

$$PW_B = B_0 \times N \tag{10}$$

The total benefit from the collective averted dose, $B_{total,}$ is the present worth of the annual benefits. B_{total} can be calculated by combining Equations 6 and 8:

$$B_{total} = \$2000 \times F \times 0.025 \times \frac{Conc}{DCGL_W} \times A \times P_D \times \frac{1 - e^{-(r+\lambda)N}}{r+\lambda} \tag{11}$$

Now consider the total cost of a remediation action, $Cost_T$. The costs included in $Cost_T$ are (1) the direct cost of the remediation action itself, $Cost_{RA}$, (2) the cost of waste disposal including its shipping cost, $Cost_{WD}$, (3), the monetary costs of workplace accidents during the remediation, $Cost_{ACC}$, (4) the monetary costs of transportation accidents during the shipping of waste, $Cost_{TF}$, (5) the monetary value of the dose that remediation workers receive, $Cost_{WDose}$, and (6) other costs as appropriate for the specific site, $Cost_{other}$. Thus,

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{other} \tag{12}$$

What is of interest in this derivation is the concentration, *Conc*, at which the benefit, $B_{total,}$ equals the total cost, $Cost_T$. Thus, in Equation 11, $Cost_T$ can be substituted for $B_{total,}$ and then Equation 11 can be solved for the concentration, *Conc,* relative to the $DCGL_W$ or $Conc/DCGL_W$ as in Equation 13.

$$\frac{Conc}{DCGL_W} = \frac{Cost_T}{\$2000 \times F \times 0.025 \times P_D \times A} \times \frac{r + \lambda}{1 - e^{-(r + \lambda)N}} \tag{13}$$

Equation 13 can be used to determine the concentration in an area for which a remediation action should be taken to meet the ALARA criterion. The equation appears complicated, but can be solved in a few minutes with a hand-held calculator, and it only has to be done once for each type of remediation action at a site. P_D, N, and r are constants. Generic values for P_D and N are given in Reference A3 or may be determined on a site-specific basis. Values for r are given in References A1 and A2. The only site-specific information that the licensee needs is the total cost, $Cost_T$, and the effectiveness, F, for each remediation action being evaluated.

REFERENCES

1. NUREG/BR-0058, Revision 2, "Regulatory Analysis Guidelines of the U. S. Nuclear Regulatory Commission," November 1995.

2. Office of Management and Budget, “Economic Analysis of Federal Regulations under Executive Order 12866,” January 11, 1996 (Available on the web at http://www1.whitehouse.gov/WH/EOP/OMB/html/miscdoc/riaguide.html).

3. NUREG-1496, “Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities,” 1997.

APPENDIX E

IMPLEMENTING THE MARSSIM APPROACH FOR CONDUCTING FINAL RADIOLOGICAL SURVEY

IMPLEMENTING THE MARSSIM APPROACH FOR CONDUCTING FINAL RADIOLOGICAL SURVEY

The U.S. Nuclear Regulatory Commission's (NRC's) regulations, 10 CFR 20.1501(a) require licensees to make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20. In order to comply with the radiological criteria for license termination (in Subpart E of 10 CFR Part 20), the licensee should conduct a final status survey.

The final status survey is the radiation survey performed after an area has been fully characterized, remediation has been completed, and the licensee believes that the area is ready to be released. The purpose of the final status survey is to demonstrate that the area meets the radiological criteria for license termination. The final status survey is not conducted for the purpose of locating residual radioactivity; the historical site assessment and the characterization survey perform that function.

NRC endorses the final status survey method described in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)." This appendix: (1) provides an overview of the MARSSIM approach for conducting a final radiological survey, (2) provides additional specific guidance on acceptable values for use in the MARSSIM method, (3) describes how to use the MARSSIM method in a way that is consistent with the dose modeling, (4) describes how to use the MARSSIM method to meet NRC's regulations, (5) and describes how to extend or supplement the MARSSIM method to certain complex situations that may be encountered, such as how to address subsurface residual radioactivity. Note that this guidance does not replace the MARSSIM and readers should refer to, and use, the MARSSIM for designing final radiological surveys to support decommissioning. This guidance assumes that the reader has a working knowledge of the MARSSIM approach and terminology and doses not attempt to provide a comprehensive overview of the entire MARSSIM.

1. CLASSIFICATION OF AREAS BY RESIDUAL RADIOACTIVITY LEVELS

The licensee should classify site areas based on levels of residual radioactivity from licensed activities. The area classification method contained in Section 4.4 of the MARSSIM is acceptable to the NRC staff. Its essential features are described below.

The licensee should first classify site areas as impacted or nonimpacted. *Impacted areas* are areas that may have residual radioactivity from the licensed activities. *Nonimpacted areas* are areas without residual radioactivity from licensed activities. Impacted areas should be identified by using knowledge of past site operations together with site characterization surveys. In the final status survey, radiation surveys do not need to be conducted in nonimpacted areas. The licensee should classify impacted areas into one of the three classes, listed below, based on levels of residual radioactivity.

> **Class 1 Areas**: Class 1 areas are impacted areas that, prior to remediation, are expected to have concentrations of residual radioactivity that exceed the $DCGL_W$. ($DCGL_W$ is defined in Section 2.2 of the MARSSIM);

Class 2 Areas: Class 2 areas are impacted areas that, prior to remediation, are not likely to have concentrations of residual radioactivity that exceed the $DCGL_W$;

Class 3 Areas: Class 3 areas are impacted areas that have a low probability of containing residual radioactivity.

Surveys conducted during operations or during characterization at the start of decommissioning are the bases for classifying areas. If the available information is not sufficient to designate an area as a particular class, the area either should be classified as Class 1 or should be further characterized. Areas that are considered to be on the borderline between classes should receive the more restrictive classification. Classifications may be changed at any time before the final status survey if more information becomes available to indicate that another classification is more appropriate.

For soils, impacted areas in Classes 1 and 2 should also be classified by whether they have substantial amounts of subsurface residual radioactivity. This classification should be based on the historical site assessment and site characterization. In this context " substantial amounts of subsurface residual radioactivity" would be defined as an amount of radioactivity, or contaminated material (such as soil) that could contribute at least 10% of the potential dose to the average member of the critical group or soil that exceeded the DCGL*emc*.

Determining whether there is a substantial amount of subsurface residual radioactivity (deeper than 15 centimeters) should not require a complex set of characterization measurements. In most cases there will be either substantial amounts of residual radioactivity or only traces such as in occasional small pockets or from leaching from surface layers by rain water. When there are small amounts of residual radioactivity below 15 centimeters, the MARSSIM survey methods for surface measurements are acceptable. When there are substantial amounts of residual radioactivity below 15 centimeters, the dose modeling and the survey methods should be modified to account for the subsurface residual radioactivity.

The presence of subsurface residual radioactivity is usually determined by the Historical Site Assessment (see Section 3 of the MARSSIM) , with knowledge of how the residual radioactivity was deposited. Characterization surveys to detect subsurface residual radioactivity in soil are not routinely conducted unless there is reason to expect that subsurface residual radioactivity may be present. The need to survey/sample subsurface soil will depend, in large part, on the quality of the information used to develop the HSA, the environmental conditions at the site, the types and forms (chemical and radiological) of the radioactive material used at the site, the authorized activities and the manner in which licensed material was managed during operations.

2. SELECTION AND SIZE OF SURVEY UNITS

The licensee should divide the impacted area into survey units based on the classification described above. A survey unit is a portion of a building or site that is surveyed, evaluated, and released as a single unit. The entire survey unit should be given the same area classification. Section 4.6 of the MARSSIM contains a method acceptable to the NRC staff for dividing impacted areas into survey units. The important features of this method are summarized here.

For buildings, it is normally appropriate to designate each separate room as either 1 or 2 survey units (e.g., floors with the lower half of walls and upper half of walls with ceiling) based on the pattern of potential of residual radioactivity. It is generally not appropriate to divide rooms of normal size (100 m^2 area or less) into more than two survey units because the dose modeling is based on the room being considered as a single unit. However, very large spaces such as warehouses may be divided into multiple survey units.

For soil, survey units should be areas with similar operational history or similar potential for residual radioactivity to the extent practical. Survey units should be formed from areas with the same classification to the extent practical, but if areas with more than one class are combined in to one survey unit, the entire survey unit should be given the more restrictive classification. Survey units should have relatively compact shapes and should not have highly irregular (gerrymandered) shapes unless the unusual shape is appropriate for the site operational history or the site topography.

Suggested survey unit areas from MARSSIM are given in Table 1. These areas are suggested in MARSSIM because they give a reasonable sampling density and they are consistent with most commonly used dose modeling codes. However, the size and shape of a particular survey unit may be adjusted to conform to the existing features of the particular site area.

Table E.1 Suggested Survey Unit Areas (MARSSIM, Roadmap Table 1).

Class	Suggested Survey Unit Area	
	Structures	Land
1	up to 100 m^2	up to 2000 m^2
2	100 to 1000 m^2	2000 to 10,000 m^2
3	no limit	no limit

3. SELECTION OF BACKGROUND REFERENCE AREAS AND BACKGROUND REFERENCE MATERIALS

3.1 Need for Background Reference Areas

Background reference areas are not needed when radionuclide-specific measurements will be used to measure concentrations of a radionuclide that is not present in background.

Background reference areas are needed for the MARSSIM method if (1) the residual radioactivity contains a radionuclide that occurs in background or (2) the sample measurements to be made are not radionuclide-specific. The survey unit itself may serve as the reference area when a surrogate radionuclide in the survey unit can be used to determine background. For example, it may be possible to use radium-226 as a surrogate for natural uranium. (More information on the use of surrogate radionuclides is provided in Section 4.3.2 of the MARSSIM).

Multiple reference areas may be used if reference areas have significantly different background levels because of the variability in background between areas. (See section 3.4 below and Section 13.2 of “A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys” NUREG-1505, June 1998). A derived reference area may be used when it is necessary to extract background information from the survey unit because a suitable reference area is not readily available. For example, it may be possible to derive a background distribution based on areas of the survey unit where residual radioactivity is not present.

3.2 Characteristics of Soil Reference Areas

The objective is to select nonimpacted background reference areas that have the same radiation concentration as the survey unit. An acceptable method for selecting background areas is contained in Section 4.5 of the MARSSIM and is briefly described below.

For soils, reference areas should have a soil type as similar to the soil type in the survey unit as possible. If there is a choice of possible reference areas with similar soil types, consideration should be given to selecting reference areas that are most similar in terms of other physical, chemical, geological, and biological characteristics. Each reference area should have an area at least as large as the survey unit, if practical, in order to include the full potential spatial variability in background concentrations. Reference areas may be offsite or onsite, as long as they are nonimpacted.

3.3 Different Materials in a Survey Unit

Survey units may contain a variety of materials with markedly different backgrounds. An example might be a room with drywall walls, concrete floor, glass windows, metal doors, wood trim, and plastic fixtures. It is not appropriate to make each material a separate survey unit because the dose modeling is based on the dose from the room as a whole and because a large number of survey units in a room would require an inappropriate number of samples.

When there are different materials with substantially different backgrounds in a survey unit, the licensee may use a reference area that is a nonimpacted room with roughly the same mix of materials as the survey unit.

If a survey unit contains several different materials, but one material is predominant or if there is not too great a variation in background among materials, a background from a reference area containing only a single material may still be appropriate. For example, a room may be mostly concrete but with some metal beams, and the residual radioactivity may be mostly on the concrete. In this situation where the concrete predominates, it would be acceptable to use a reference area that contained only concrete. However, the licensee should demonstrate that the selected reference area will not result in underestimating the residual radioactivity on other materials.

The licensee may also use measured backgrounds for the different materials or for groups of similar materials. When the licensee decides to use different measured backgrounds for different materials or for a group of materials with similar backgrounds, it is acceptable to perform a one-sample test on the difference between the paired measurements from the survey unit and from the appropriate reference material. An acceptable method to do this is described in detail in Chapter 12 of NUREG-1505.

For materials present onsite, either in buildings or as nonsoil materials present in outdoor survey units (e.g., concrete, brick, drywall, fly ash, petroleum product wastes), the licensee should attempt to find nonimpacted materials that are as similar as possible to the materials on the site. Sometimes such materials will not be available. In those situations, the licensee should make a good faith effort to find the most similar materials readily available or use appropriate published estimates.

3.4 Differences in Backgrounds Between Areas

When using a single reference area, any difference in the mean radionuclide concentration between the survey unit and the reference area would be interpreted as caused by residual radioactivity from site operations. This interpretation may not be appropriate when the variability in mean background concentrations among different reference areas is a substantial fraction of the $DCGL_W$. When there may be a significant difference in backgrounds between different areas, a Kruskal-Wallis test, as described in Chapter 13 of NUREG-1505, can be conducted to determine whether there are, in fact, significant differences in mean background concentrations among potential reference areas.

While NUREG-1505 does not recommend specific values for the Kruskal-Wallis test, the NRC staff recommends at least 15 samples in each of at least 4 reference areas and a Type I error rate of $\alpha_{KW} = 0.2$ to provide an adequate number of measurements for the determination of whether there is a significant difference in the background concentrations. However, different values may be appropriate on a site-specific basis.

If significant differences in backgrounds among reference areas are found, the NRC staff recommends that a value of three times the standard deviation of the mean of the reference area background values should be added to the mean of the reference area background to define a background concentration. A value of three times the standard deviation of the mean is chosen to minimize the likelihood that a survey unit that contains only background would fail the statistical test for release. A two-sample test (see Section 4, below) should then be used to test whether the survey unit meets the radiological criteria for license termination. This method is described in detail in Chapter 13 of NUREG-1505.

4. METHODS TO EVALUATE SURVEY RESULTS

All survey units should be evaluated to determine whether the average concentration in the survey unit as a whole is below the $DCGL_W$. If the radionuclide is not present in background and the measurement technique is radionuclide-specific so that comparison with a reference area is not necessary, a one-sample test, the Sign test, should be used. This test is described in Section 8.3 of the MARSSIM.

When the residual radioactivity contains a radionuclide present in the environment or when the measurements are not radionuclide-specific, the survey unit should be compared to a reference area. When the survey unit will be compared to a reference area, a two-sample test, the Wilcoxon Rank Sum (WRS) test, should be used. This test is described in Section 8.4 of the MARSSIM.

4.1 A Case for Not Subtracting Background

An exception to using a two-sample test when a radionuclide is present in background is when the licensee plans to assume that all the radionuclide activity in the survey unit is caused by licensed operations and none is from background. This could be the case for cesium-137, for example, because the levels in the environment are often so much less than the $DCGL_W$ that background concentrations may be ignored.

4.2 Elevated Measurements Comparison

Class 1 survey units that pass the sign test or WRS test but have small areas with concentrations exceeding the $DCGL_W$ should also be tested to demonstrate that those small areas meet the dose criteria for license termination. This test is called the elevated measurement comparison. It is described in Section 8.5.1 of the MARSSIM and summarized here.

To perform the elevated measurement comparison, the size of the area in the survey unit with a concentration greater than the $DCGL_W$ is determined, then the area factor for an area of that size is determined. (The area factor is the multiple of the $DCGL_W$ that is permitted in a limited area of a survey unit. See section 7.5, below). The average concentration in the area is also determined. The elevated measurement comparison is acceptable if the following condition is met (MARSSIM Equation 8-2):

$$\frac{\delta}{DCGL_W} + \frac{\text{average concentration in the elevated area} - \delta}{\text{area factor for elevated area} \times DCGL_W} < 1 \qquad \textbf{(E1)}$$

where δ = the average residual radioactivity concentration for all sample points

If there is more than one elevated area, a separate term should be included for each one.

As an alternative to the unity rule expressed in Equation 1, the dose from the actual distribution of residual radioactivity can be calculated if there is an appropriate exposure pathway model available.

5. INSTRUMENT SELECTION AND CALIBRATION

To demonstrate that the radiological criteria for license termination have been met, the measurement instruments should have an adequate sensitivity, be calibrated properly, and be checked periodically for proper response.

5.1 Calculation of Minimum Detectable Concentrations

The licensee should determine the minimum detectable concentration (MDC) for the instruments and techniques that will be used. The MDC is the concentration that a specific instrument and technique can be expected to detect 95% of the time under actual conditions of use.

For scanning building surfaces for beta and gamma emitters, the MDC_{scan} should be determined from the following equation (obtained by combining MARSSIM equations 6-8, 6-9, and 6-10 and using a value recommended in this guide for the index of sensitivity *d'* of 1.38, which is for 95% detection of a concentration equal to MDC_{scan} with a 60% false-positive rate).

$$MDC_{scan}\ (building\ surfaces) = \frac{270{,}000 \times 1.38\ \sqrt{B}}{\sqrt{p}\ \varepsilon_i\ \varepsilon_s\ A\ t} \qquad \textbf{(E2)}$$

where:	MDC_{scan}	=	minimum detectable concentration for scanning building surfaces in pCi/m^2
	270,000	=	conversion factor to convert to pCi/m^2
	1.38	=	index of sensitivity *d'*
	B	=	number of background counts in time interval t
	p	=	surveyor efficiency
	ε_i	=	instrument efficiency for the emitted radiation
	ε_s	=	source efficiency in emissions/disintegration
	A	=	probe's sensitive area in cm^2
	t	=	time interval of the observation while the probe passes over the source in seconds

Based on the measurements described in "Human Performance in Radiological Survey Scanning" NUREG/CR-6364, March 1997, a surveyor efficiency p of 0.5 represents a mean value for normal field conditions and its use is generally acceptable. If the licensee wants to determine a value appropriate for particular measurement techniques, the information in Reference 7 describes how the value can be determined.

For scanning soil with a sodium iodide gamma detector, the MDC_{scan} values given in Table 6.7 of MARSSIM provide an acceptable estimate of MDC_{scan}.

For static measurements of surface concentrations, the MDC_{static} may be calculated using the following equation (from "Minimum Detectable Concentrations with Typical Radiation Survey

Instruments for Various Contaminants and Filed Conditions, NUREG-1507, June 1998, Equation 3-10:

$$MDC_{static} = \frac{3 + 4.65\sqrt{B}}{K\ t} \qquad \textbf{(E3)}$$

where: MDC_{static} = minimum detectable concentration in pCi/m^2 or pCi/g
B = background counts during measurement time interval t
t = counting time in seconds
K = a calibration constant (best estimate) to convert counts/second to pCi/m^2 or pCi/g and is discussed further in NUREG-1507.

An example using this equation is shown in Section 6.7.1 of the MARSSIM.

The instruments used for sample measurements at the specific sample locations should have an MDC_{static} less than 50% of the $DCGL_W$ as recommended in Section 4.7.1 of MARSSIM. There is no specific recommendation for the MDC_{scan}, but the MDC_{scan} will determine the number of samples needed, as discussed in Section 7.5.

The licensee should record all numerical values measured, even values below the "minimum detectable concentration" or "critical level," including values that are negative (when the measured value is below the average background). Entries for measurement results should not be "nondetect," "below MDC," or similar entries because the statistical tests can only tolerate a maximum of 40% nondetects.

5.2 Instrument Calibration and Response Checks

NRC regulations at 10 CFR 20.1501(b) require that the licensee periodically calibrate radiation measurement instruments used in surveys such as the final status survey.

For in situ gamma measurements, the detector efficiency (count rate per unit fluence rate) should be determined for the gamma energies of interest and the assumed representative depth distribution. The surface and volumetric distributions should be explicitly considered to evaluate potential elevated areas. To calibrate for the representative depth distribution, acceptable methods are to (1) use a test bed with radioactive sources distributed appropriately or (2) use primarily theoretical calculations that are normalized or verified experimentally using a source approximating a point source. The calibration of the source used for the verification source should be traceable to a recognized standards or calibration organization, for example, the National Institute of Standards and Technology.

Some modern instruments are very stable in their response. Thus, as long as instrument response checks are performed periodically to verify that the detector is operating properly, it may be acceptable to calibrate only initially without periodic recalibrations. The initial calibration may be performed by either the instrument supplier or the licensee, but in either case, 10 CFR 20.2103(a) requires that a record describing the calibration be available for inspection by the NRC.

5.3 Instrument Response Checks

The response of survey instruments should be checked with a check source to confirm constancy in instrument response each day before use. Licensees should establish criteria for acceptable response. If the response is not acceptable, the instrument should be considered as not responding properly and should not be used until the problem has been resolved. Measurements made after the last acceptable response check should be evaluated and discarded, if appropriate.

The check source should emit the same type of radiation (i.e., alpha, beta, gamma) as the radiation being measured and should give a similar instrument response, but the check source does not have to use the same radionuclide as the radionuclide being measured.

6. SCANNING COVERAGE FRACTIONS AND INVESTIGATION LEVELS

Scanning is performed to locate small areas of elevated concentrations of residual radioactivity to determine whether they meet the radiological criteria for license termination. The licensee should perform scanning in each survey unit to detect areas of elevated concentrations. The licensee should establish investigation levels for investigating significantly elevated concentrations of residual radioactivity. Acceptable scanning coverage fractions and scanning investigation levels for buildings and land areas are shown in Table 2. This table is based on MARSSIM Roadmap Table 2 and Table 5.8.

Systematic scans are those conducted according to a preset pattern. Judgmental scans are those conducted to include areas with a greater potential for residual radioactivity. In Class 2 areas, a 10% scanning coverage would be appropriate when there is high confidence that all locations would be below the $DCGL_W$. A coverage of 25 percent to 50percent would be appropriate when there may be locations with concentrations near the $DCGL_W$. A coverage of 100% would be appropriate if there is any concern that the area should have had a Class 1 classification rather than a Class 2 classification. In Class 3 areas, scanning coverage is usually less than 10 percent. If any location exceeds the scanning investigation level, scanning coverage in the vicinity of that location should be increased to delineate the elevated area.

Table E.2 Scanning Coverage Fractions and Scanning Investigation Levels

Class	Scanning Coverage Fraction	Scanning Investigation Levels
1	100%	> $DCGL_{EMC}$
2	10 to 100% for soil and for floors and lower walls of buildings. 10 to 50% for upper walls and ceilings of buildings. Systematic and judgmental.	> $DCGL_W$ or > MDC_{scan} if MDC_{scan} is greater than $DCGL_W$.
3	Judgmental.	> $DCGL_W$ or > MDC_{scan} if MDC_{scan} is greater than $DCGL_w$.

Sometimes the sensitivity of static measurements at designated sample points is high enough to detect significantly elevated areas between sample points. If the sensitivity is high enough, only this single set of measurements is necessary. For example, both scanning and sampling for cobalt-60, which emits an easily detectable gamma, can be done with a single set of in situ measurements in some cases.

7. DETERMINING THE NUMBER OF SAMPLES NEEDED

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The method described below from Chapter 5 of the MARSSIM is acceptable for determining the number of samples needed.

7.1 Determination of the Relative Shift

The number of samples needed will depend on a ratio involving the concentration to be measured relative to the variability in the concentration. The ratio to be used is called the relative shift, Δ/σ_s. The relative shift, Δ/σ_s, is defined in Section 5.5.2.2 of the MARSSIM as:

$$\Delta/\sigma_s = \frac{DCGL_W - LBGR}{\sigma_s} \qquad \textbf{(E4)}$$

where:

$DCGL_W$ = derived concentration guideline

$LBGR$ = concentration at the lower bound of the gray region. The *LBGR* is the concentration to which the survey unit must be cleaned in order to have an acceptable probability of passing the test (i.e., 1-β).

σ_s = an estimate of the standard deviation of the concentration of residual radioactivity in the survey unit (which includes real spatial variability in the concentration as well as the precision of the measurement system)

The value of σ_s is determined either from existing measurements or by taking limited preliminary measurements of the concentration of the residual radioactivity in the survey unit at about 5 to 20 locations as recommended in Section 5.5.2.2 of the MARSSIM. If a reference area will be used and the σ_r in the reference area is larger than the σ_s in the survey unit, the larger value should be used.

NRC endorses the MARSSIM recommendation to initially set the *LBGR* equal to 0.5 $DCGL_W$. If the relative shift, Δ/σ_s, exceeds 3, the *LBGR* should be increased until Δ/σ_s is equal to 3. The licensee may refer to MARSSIM, Appendix D, for additional details and information.

7.2 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by failing a survey unit that should pass or by passing a survey unit that should fail. When using the statistical tests, larger decision errors may be unavoidable when encountering difficult or adverse measuring conditions. This is particularly true when trying to measure residual radioactivity concentrations close to the variability in the concentration of those materials in natural background.

The α decision error is the probability of passing a survey unit whose actual concentration exceeds the release criterion. A decision error α of 0.05 is acceptable under the more favorable conditions when the relative shift, Δ/σ_s, is large (about 3 or greater). Larger values of α may be considered when the relative shift is small to avoid an unreasonable number of samples. The β decision error is the probability of failing a survey unit whose actual concentration is equal to *LBGR*. Any value of β is acceptable to the NRC.

7.3 Number of Samples Needed for the Wilcoxon Rank Sum (WRS) Test

The minimum number of samples, *N*, needed in each survey unit for the WRS test may be determined from the following equation (MARSSIM equation 5-1 with *N* redefined as the number of samples in the survey unit):

$$N = \frac{1}{2} \times \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3\ (P_r - 0.5)^2} \qquad \textbf{(E5)}$$

where:	N	=	the number of samples in the survey unit
	$Z_{1-\alpha}$	=	the percentile represented by the decision error α
	$Z_{1-\beta}$	=	the percentile represented by the decision error β
	P_r	=	the probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the $DCGL_W$ when the survey unit median is equal to the *LBGR* concentration above background
	½	=	a factor added to MARSSIM equation 5-1 because *N* always is defined in this guide as the number of samples in the survey unit

Values of P_r, $Z_{1-\alpha}$, and $Z_{1-\beta}$, are tabulated in Tables 5.1 and 5.2 of MARSSIM. N is the minimum number of samples necessary in each survey unit. An additional N samples will also be needed in the reference area. If N is not an integer, the number of samples is determined by rounding up. In addition, the licensee should consider taking some additional samples (MARSSIM recommends 20%) to protect against the possibility of lost or unusable data. Fewer samples increase the probability of an acceptable survey unit failing to demonstrate compliance with the radiological criteria for release.

7.4 Number of Samples Needed for Sign Test

The number of samples N needed in a survey unit for the Sign test may be determined from the following equation (MARSSIM equation 5-2):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4\ (Sign\ p - 0.5)^2} \qquad \textbf{(E6)}$$

where:	N	=	number of samples needed in a survey unit
	$Z_{1-\alpha}$	=	percentile represented by the decision error α
	$Z_{1-\beta}$	=	percentile represented by the decision error β
	Sign p	=	estimated probability that a random measurement for the survey unit will be less than the $DCGL_W$ when the survey unit median concentration is actually at the *LBGR*.

Values of $Z_{1-\alpha}$, $Z_{1-\beta}$, and *Sign p* are tabulated in Tables 5.2 and 5.4 of MARSSIM. In addition, the licensee should consider taking some additional samples (MARSSIM recommends 20%) to protect against the possibility of lost or unusable data. Fewer samples increase the probability of an acceptable survey unit failing to demonstrate compliance with the radiological criteria for release. If a survey unit fails to demonstrate compliance because there were not enough samples taken, a totally new sampling effort may be needed unless resampling was planned for.

7.5 Additional Samples for Elevated Measurement Comparison in Class 1 Areas

Additional samples may be needed when the concentration that can be detected by scanning, MDC_{scan}, is larger than the $DCGL_W$. The licensee should determine whether additional samples are needed in Class 1 survey units for the elevated measurement comparison when the concentration that can be detected by scanning, MDC_{scan}, is larger than the $DCGL_W$. The method in section 5.5.2.4 of the MARSSIM to determine whether additional samples are needed is acceptable to the NRC staff and is described here.

The area factor is the multiple of the $DCGL_W$ that is permitted in a limited portion of the survey unit. The ratio of the MDC_{scan} to the $DCGL_W$ establishes the area factor (the multiple of the $DCGL_W$) that can be detected by scanning (MARSSIM equation 5-4):

$$area\ factor = \frac{MDC_{scan}}{DCGL_W} \qquad \textbf{(E7)}$$

Using the methods in "Guidance on Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination", NUREG-1549 June 1998, the size of the area corresponding to the area factor, A_{EC}, can be determined. The number of sample points that may be needed to detect this area of elevated measurement concentration, N_{EMC}, in a survey unit is:

$$N_{EMC} = \frac{A}{A_{EC}} \qquad \textbf{(E8)}$$

where A = the area of the survey unit
A_{EC} = the area of concentration greater than $DCGL_W$

If N_{EMC} is larger than N, additional samples may be needed to demonstrate that areas of elevated concentrations meet the radiological criteria for license termination. However, the number of samples needed is not necessarily N_{EMC}. To determine how many additional samples may be needed, the historical site assessment and site characterization should be considered. Based on what is known about the site, it may be possible to estimate a concentration that is unlikely to be exceeded. If there is a maximum concentration, the size of the area corresponding to this area factor for this concentration may be used for A_{EC} in Equation 8. Similarly, based on knowledge of how the radioactive material was handled or dispersed on the site, it may be possible to estimate the smallest area likely to have elevated concentrations. If this is so, that area can be used in Equation 8. Likewise, knowledge of how the residual radioactivity would be likely to spread or diffuse after deposition could be used to determine an area A_{EC} for Equation 8.

It has been shown in Figure D-7 of Appendix D to MARSSIM and in Section 3.7.2 of NUREG-1505 that a triangular grid is slightly more effective in locating areas of elevated concentrations. Therefore, a triangular grid generally should be used if N_{EMC} is significantly larger than N and if areas similar in size or smaller than the grid spacing are expected to have concentrations at or above the area factor.

8. DETERMINING SAMPLE LOCATIONS

The licensee should establish a reference coordinate system for the impacted areas. A reference coordinate system is a set of intersecting lines referenced to a fixed site location or benchmark. Reference coordinate systems are established so that the locations of any point in the survey unit can be identified by coordinate numbers. A reference coordinate system does not establish the number of sample points or determine where samples are taken. A single reference coordinate system may be used for a site, or different coordinate systems may be used for each survey unit or for a group of survey units. Section 4.8.5 of the MARSSIM describes an acceptable method to establish a reference coordinate system.

In Class 1 and Class 2 areas, the sampling locations are established in a regular pattern, either square or triangular. The method described below is from in Section 5.5.2.5 of the MARSSIM.

After the number of samples needed in the survey unit has been determined and the licensee has decided whether to use a square or triangular grid, sample spacings are determined from the equations below (adapted from MARSSIM equations 5-5, 5-6, 5-7, and 5-8).

$$L = \sqrt{\frac{A}{0.866\ N}} \quad \textit{for a triangular grid} \tag{E9}$$

$$L = \sqrt{\frac{A}{N}} \quad \textit{for a square grid} \tag{E10}$$

where	*A*	=	the survey unit area
	N	=	the number of samples needed (in Class 1 areas, the larger of the number for the statistical test or the elevated measurement. comparison)

The calculated value of *L* is then often rounded downward to a shorter distance that is easily measured in the field.

A random starting point should be identified for the survey pattern. The coordinate location of the random starting point should be determined by a set of two random numbers, one representing the *x* axis and the other the *y* axis. The random numbers can be generated by calculator or computer or can be obtained from a table of random numbers. Each random number should be multiplied by the appropriate survey unit dimension to provide a coordinate relative to the origin of the survey unit reference coordinate system.

Beginning at the random starting point, a row of points should be identified parallel to the *x* axis at intervals of *L*. For a square grid, the additional rows should be parallel to the first row at a distance of *L* from the first row. For a triangular grid, the distance between rows should be 0.866 *L*, and the sample locations in the adjacent rows should be midway on the *x* axis between the sample locations in the first row. Sample locations selected in this manner that do not fall within the survey unit area or that cannot be surveyed because of site conditions should be replaced with other sample locations determined using the same random selection process that was used to select the starting point. An example illustrating the triangular grid pattern is shown in MARSSIM in Figure 5.5.

In Class 3 survey units and in reference areas, all samples should be taken at random locations. Each sample location should be determined by a set of two random numbers, one representing the *x* axis and the other the *y* axis. Each set of random numbers should be multiplied by the appropriate survey unit dimension to provide coordinates relative to the origin of the survey unit reference coordinate system. Coordinates identified in this manner that do not fall within the survey unit area or that cannot be surveyed because of site conditions should be replaced with other sample locations determined in the same manner. MARSSIM Figure 5.4 illustrates a random sample location pattern.

9. DETERMINATION OF COMPLIANCE

The licensee should first review the measurement data to confirm that the survey units were properly classified. The MARSSIM Section 8.2.2, contains methods for this review that are acceptable to the NRC staff. If the final status survey shows that an area was misclassified with a less restrictive classification, the area should receive the correct classification and the final status survey for the area should be repeated. A pattern of misclassifications that are not restrictive enough indicates that the characterization was not adequate. In this case, the site or portions of the site in question should be characterized again, reclassified, and resurveyed for the new classification.

The licensee should then determine whether the measurement results demonstrate that the survey unit meets the radiological criteria for license termination. Tables 3 and 4, below summarize an acceptable way to interpret the sample measurements. The WRS test is described in Section 8.4 of the MARSSIM. The Sign test is described in Section 8.3 of the MARSSIM. The elevated measurement comparison is described in Section 8.5 of the MARSSIM. The elevated measurement is applied to all sample measurements and all scanning results that exceed the $DCGL_W$.

Some facilities may have residual radioactivity composed of more than one radionuclide. When there are multiple radionuclides rather than a single radionuclide, the dose contribution from each radionuclide needs to be considered.

When there is a fixed ratio among the concentrations of the nuclides, such as for radionuclides that are in secular equilibrium, a $DCGL_W$ for each nuclide can be calculated. Compliance with the radiological criteria for license termination may be demonstrated by comparing the concentration of the single radionuclide that is easiest to measure with its $DCGL_{W.}$

When there is no fixed ratio among the concentrations of the nuclides, it is necessary to evaluate the concentration of each nuclide. Compliance with the radiological criteria for license termination is then demonstrated by considering the sum of the concentration of each nuclide relative to its $DCGL_W$, calculated as if it were the only nuclide present. An acceptable method for performing the evaluation is described in Chapter 11 of NUREG-1505.

In some cases in which multiple nuclides are present with no fixed ratio in their concentrations, the dose contribution from one or more of the nuclides in the mixture will dominate the total dose, and the dose from other radionuclides will be insignificant. For example, at a nuclear power plant, many different radionuclides could be present with no fixed ratio in their concentrations, but almost all the dose would come from just one or two of the nuclides. In this situation, the presence of nuclides that likely contribute less than 10% of the total effective dose equivalent may be ignored.

Table E3. Interpretation of Sample Measurements When Reference Area Is Used

Measurement results	Conclusion
Difference between maximum survey unit concentration and minimum reference area concentration is less than $DCGL_W$.	Survey unit meets release criterion
Difference between survey unit average concentration and reference area average concentration is greater than $DCGL_W$.	Survey unit fails
Difference between any survey unit concentration and any reference area concentration is greater than $DCGL_W$ and the difference of survey unit average concentration and reference area average concentration is less than $DCGL_W$	Conduct WRS test and elevated measurement comparison

Table E4. Interpretation of Sample Measurements When No Reference Area Is Used

Measurement results	Conclusion
All concentrations are less than $DCGL_W$	Survey unit meets release criterion
Average concentration is greater than $DCGL_W$	Survey unit fails
Any concentration is greater than $DCGL_W$ and average concentration less than $DCGL_W$	Conduct Sign test and elevated measurement comparison

If a survey unit fails, the licensee should evaluate the measurement results and determine why the survey unit failed. MARSSIM provides acceptable methods for reviewing measurement results in Sections 8.2.2 and 8.5.3 and in Appendix D. If it appears that the failure was caused by the presence of residual radioactivity in excess of that permitted by the radiological release criteria, the survey unit should be re-remediated and resurveyed. However, some failures may not be caused by the presence of residual radioactivity. If it can be determined that this is the case, the survey unit may be released.

10. SURVEYS FOR SPECIAL SITUATIONS IN BUILDINGS

The survey method described in this section thus far can be applied to simple ideal geometries in a straightforward manner. However, at actual sites there are likely to be some special situations that will need special consideration. For each situation discussed below, it is assumed that the historical site assessment and site characterization have located and given a rough estimate of the concentration of residual radioactivity present.

10.1 Residual Radioactivity Beneath the Surface

The historical site assessment and characterization surveys may indicate that residual radioactivity is present beneath the surface. In the dose modeling, the parameters for resuspension and ingestion are normally derived for residual radioactivity on the surface. However, if the residual radioactivity is beneath rather than on the surface, that may be considered in the dose modeling and the survey results may be interpreted in a manner consistent with the dose modeling.

For the final status survey, cracks and crevices are surveyed the same as other building surfaces except that they should be included in places receiving judgmental scans when scanning coverage is less than 100%.

For painted-over residual radioactivity, the historical site assessment and characterization surveys should be used to determine whether residual radioactivity was fixed in place by being painted over. If so, the process for its removal may be considered in developing the parameters for the dose modeling, and the survey results may be interpreted in a manner consistent with the dose modeling.

10.2 Sewer Systems, Waste Plumbing Systems, and Floor Drains

The historical site assessment and characterization surveys are used to determine whether there are unusual or unexpected levels of residual radioactivity in sewer systems and floor drains. Residual radioactivity in sewer systems and floor drains generally does not contribute to the dose pathways in the building occupancy scenario or the residential scenario; thus, the dose from residual radioactivity in sewer pipes should be calculated using a site-specific scenario. The final status survey should then be conducted in a manner consistent with the site-specific dose scenario. If the sewer water is sent to an onsite drainage field or cesspool, any residual radioactivity should be evaluated and surveyed as subsurface residual radioactivity. If unusual or unexpected results are found during the characterization survey, the situation will be dealt with on a case-by-case basis.

If sewage is sent to an onsite drainage field, any residual radioactivity is subsurface and the survey methods discussed in Section 11.1, below, are appropriate.

10.3 Ventilation Ducts

The historical site assessment and characterization surveys should be used to indicate whether residual radioactivity may be present. External duct surfaces of ventilation ducts are surveyed as if they are a part of the building surface. For internal duct surfaces, surveys should be performed consistent with the dose modeling assumptions.

10.4 Piping and Embedded Piping

Embedded piping is piping embedded in a durable material, typically concrete, that cannot be easily removed without significant effort and tools. The historical site assessment and characterization surveys should be used to indicate whether residual radioactivity is present in piping. The normal room surveys will adequately account for direct (external gamma) radiation from the pipes when the pipes are in place and undisturbed. The direct (external gamma) dose from the pipes will be in addition to the total effective dose equivalent from the residual radioactivity on surfaces in the room. It may also be necessary to consider renovation of the building that would disturb the piping as described in “Residual Radioactive Contamination from Decommissioning” NUREG/CR-5512, March 1998. If this is done, the survey should be consistent with the dose modeling assumptions.

11. SURVEYS FOR SPECIAL SITUATIONS ON LAND

11.1 Subsurface Residual Radioactivity

The MARSSIM final status survey method was designed specifically for residual radioactivity in the top 15 centimeters of soil. If significant amounts of residual radioactivity are deeper than 15 centimeters, this should be taken into consideration in performing the final status survey.

The licensee should first determine whether there is a need for surveys of subsurface residual radioactivity. The historical site assessment will usually be sufficient to indicate whether there is likely to be subsurface residual radioactivity. If the historical site assessment indicates that there is no likelihood of substantial subsurface residual radioactivity, subsurface surveys are not necessary.

If the historical site assessment indicates that there is substantial subsurface residual radioactivity and the licensee plans to terminate the license with some subsurface residual radioactivity in place, the final status survey should consider the subsurface residual radioactivity in order to demonstrate compliance with the radiological criteria for license termination. To prepare for the final status survey, the characterization survey determines the depth of the residual radioactivity. The $DCGL_W$ may be based on the assumption that the residual radioactivity may be excavated some day and that mixing of the residual radioactivity will occur during excavation. When the subsurface residual radioactivity is mixed and brought to the surface, most of the dose pathways will depend only on the average concentration. Only the groundwater pathways are affected by the total inventory of residual radioactivity, including that deeper than 15 centimeters. The direct, inhalation, ingestion, and crop pathways are determined by concentration only, not total inventory.

When the appropriate *DCGLs* and mixing volumes based on an acceptable site-specific dose assessment are established, the final site survey is performed by taking core samples to the measured depth of the residual radioactivity. The number of cores to be taken is the number *N* required for the WRS or Sign test, as appropriate. However, the mixing volume assumed in the scenario may require a larger number of core samples. There is no adjustment to the grid spacing for the elevated measurement comparison because scanning is not applicable. The core samples should be homogenized over each 1 meter of depth. Then the appropriate test (WRS or Sign) is applied to the set of samples. In addition, each individual core sample is also tested against a site-specific volumetric elevated measurement comparison. Triangular grids are recommended because they are slightly more effective in locating areas of elevated concentrations.

The sampling approach described above may not be necessary if sufficient data to characterize the subsurface residual radioactivity are available from other sources. For example, for some burials conducted under prior NRC regulations, the records on the material buried may be sufficient to demonstrate compliance with the radiological criteria for license termination.

Note that MARSSIM may be revised in the future to better describe acceptable methods to evaluate subsurface soil. This appendix will be revised to reflect any changes to MARSSIM when they are finalized.

11.2 Rubble, Debris, and Rocks

Rocks and debris can include naturally occurring rocks, either in place or in piles, pieces of concrete or rubble from buildings that have been razed, sheet metal disposed of as trash, and similar material. The historical site assessment and characterization surveys should be used to determine whether the volumetric residual radioactivity concentration may be greater than the *DCGL* for soil (based on the approximate size of the pile). If the materials are highly contaminated, they would be disposed of as radioactive waste. If the radioactivity is not substantially elevated, the rubble, debris, and rocks may be evaluated as part of a larger survey unit. The same is true for other nonsoil foreign materials such as asphalt and fly ash. When these materials will be evaluated as part of a larger survey unit and when they are found on a relatively small fraction of the area of a survey unit, the volumetric soil $DCGL_W$ should be used uniformly throughout the survey unit. Areas covered by these materials would not normally be expected to be appropriate for farming or a house site. Because of this, the $DCGL_W$ calculated for soil is expected to be conservative if used for rocks and other debris. In this case, the area should be scanned like the rest of the survey unit, and the sampling locations in the survey unit should be selected without regard to the location of the pile.

11.3 Paved Parking Lots, Roads, and Other Paved Areas

The historical site assessment and characterization surveys should be used to determine whether the residual radioactivity is on or near the surface of the paving and whether there are significant concentrations of residual radioactivity beneath the paving. If the residual radioactivity is primarily on top of the paving, the measurements should be taken as if the area were normal soil. Depending on how large the paved area is, the paved area may be included as part of a larger survey unit or may be its own survey unit. If the residual radioactivity is primarily beneath the paving, it should be surveyed as subsurface residual radioactivity, as discussed above.

11.4 Ground Water

The need for surveys of ground water should be determined from the historical site assessment. If the historical site assessment indicates that residual radioactivity may have reached potable water, surveys of ground water would be appropriate. The nature of appropriate ground water surveys should be determined on a site-specific basis and is outside the scope of this guide.

11.5 Surface Water and Sediments

Surface water can include ponds, creeks, and other bodies of water. The need for surface water samples should be evaluated on a case-by-case basis. Surveys for water should be based on appropriate environmental standards for water sampling.

If the body of water is included in a larger survey unit, sediment samples should be taken at sample locations selected by the normal method without taking the body of water into consideration.

APPENDIX F

STANDARD FORMAT AND CONTENT OF
FINANCIAL ASSURANCE MECHANISMS FOR DECOMMISSIONING

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this Appendix is to provide guidance to NRC licensees and license applicants on how to demonstrate financial assurance for decommissioning and, if applicable, for site control and maintenance following license termination. The Appendix also establishes a standard format for presenting the information to NRC that will (1) aid the licensee or license applicant in ensuring that the information is complete, (2) help ensure that applicable requirements in 10 CFR Parts 30, 40, 70, and 72 have been met, and (3) help achieve the intent of the regulations, which is to ensure that the decommissioning of all licensed facilities will be accomplished in a safe and timely manner and that licensees will provide adequate funds to cover all costs associated with decommissioning and, if applicable, with site control and maintenance.

> **Overview of Financial Assurance**
>
> Financial assurance requirements help ensure that adequate funds will be available to pay for certain costs (e.g., decommissioning) in a timely manner. Financial assurance is achieved through the use of financial instruments. Some financial instruments provide a special account into which the licensee may essentially prepay the applicable costs. Other financial instruments guarantee funding by a suitably-qualified third party, thereby providing "defense in depth" in the event the licensee is unable or unwilling to pay these costs when they arise. Financial assurance for decommissioning must be obtained prior to the commencement of licensed activities or receipt of licensed material, and it must be maintained until termination of the license. If the license is being terminated under restricted conditions, then financial assurance for site control and maintenance must be obtained prior to license termination. The amount of financial assurance obtained is often based on a site-specific cost estimate and must be increased if the cost estimate increases. Under NRC regulations, a number of different types of financial instruments may be used to demonstrate financial assurance, including trusts, letters of credit, surety bonds, and guarantees.

This Appendix applies only to licensees and license applicants covered under the following parts of 10 CFR:

- *Part 30 - Byproduct Material*. Financial assurance requirements are found at 10 CFR 30.35 and 30.36.

- *Part 40 - Source Material (except uranium recovery facilities)*. Financial assurance requirements are found at 10 CFR 40.36 and 40.42.

- *Part 70 - Special Nuclear Material*. Financial assurance requirements are found at 10 CFR 70.25 and 70.38.

- *Part 72 - Independent Spent Fuel Storage Installations*. Financial assurance requirements are found at 10 CFR 72.30 and 72.54.

- *Part 20 (Subpart E) - License Termination*. Financial assurance requirements are found at 10 CFR 20.1403.

Other documents also address the decommissioning financial assurance requirements. Guidance on uranium recovery facilities under Part 40 is provided in "Technical Position on Financial Assurances for Reclamation, Decommissioning, and Long-Term Surveillance and

Control of Uranium Recovery Facilities" (October 1988). Information on low-level waste disposal facilities under 10 CFR Part 61 is provided in Revision 1 of NUREG-1199, "Standard Format and Content of a License Application for a Low-Level Radiative Waste Disposal Facility" (January 1988), and Revision 3 of NUREG-1200, "Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility" (March 1994).

The information collections contained in this Appendix are covered by the requirements of 10 CFR Parts 30, 40, 70, and 72, which were approved by the Office of Management and Budget, approval numbers 3150-0017, 3150-0020, 3150-0009, and 3150-0132, respectively. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

1.1 HOW TO USE THIS APPENDIX

This Appendix is organized around the various components of a financial assurance demonstration (e.g., the cost estimate, the financial instrument). Each component of a financial assurance demonstration is addressed briefly in this introduction and then is addressed again in greater detail in its own section. Each subsequent section provides narrative guidance on a particular component and contains one or more checklists to help guide the reader. By completing the tasks on the checklists, a licensee or applicant can be sure that its financial assurance demonstration is complete and likely to be acceptable to the NRC.

Licensees and applicants should read this Section 1 in its entirety. It includes a "master" checklist that directs the reader to other relevant sections and checklists in this Appendix. To prepare a financial assurance demonstration that is likely to be acceptable to the NRC, a licensee or applicant should simply complete the following steps.

1. Complete Checklist 1 (the master checklist);

2. Complete applicable checklists called for by Checklist 1;

3. Prepare any documentation called for in the completed checklists; and

4. Submit the completed checklists and accompanying documentation to the NRC for review and approval.

CHECKLIST 1

MASTER CHECKLIST FOR DECOMMISSIONING FINANCIAL ASSURANCE

Name of Licensee/Applicant ______________________________
Mailing Address ______________________________
____
Facility Address ______________________________
____
License Number(s) ______________________________
Date of Submission ______________________________

Applicable Parts of 10 CFR (check all that apply):
- ☐ Part 30
- ☐ Part 40
- ☐ Part 70
- ☐ Part 72

Type of Submission:
- ☐ Certification of Financial Assurance → attach Checklist 2
- ☐ Decommissioning Funding Plan → attach Checklist 3
- ☐ Decommissioning Plan → attach Checklist 18

Type of Mechanism:

- ☐ Prepayment
  - ☐ Trust → attach Checklist 4-A
  - ☐ Escrow Account → attach Checklist 5-A
  - ☐ Government Fund → attach Checklist 6-A
  - ☐ Certificate of Deposit → attach Checklist 7-A
  - ☐ Deposit of Government Securities → attach Checklist 8-A
- ☐ Surety, Insurance, or Other Guarantee Method
  - ☐ Surety Bond → attach Checklist 9-A
  - ☐ Letter of Credit → attach Checklist 10-A
  - ☐ Line of Credit → attach Checklist 11-A
  - ☐ Insurance → attach Checklist 12-A
  - ☐ Parent Company Guarantee → attach Checklist 13-A
  - ☐ Self-Guarantee → attach Checklist 14-A
- ☐ External Sinking Fund → attach Checklist 15-A
- ☐ Statement of Intent → attach Checklist 16-A
- ☐ Special Arrangement with a Government Entity → attach Checklist 18-A

To help licensees and applicants make the initial decisions called for in Checklist 1, this Section 1 discusses each of the three major decision points:

- Confirmation that financial assurance is required (see Section 1.2)
- Use of a Certification or a Decommissioning Funding Plan (see Section 1.3)
- Selection of a financial instrument (see Section 1.4)

Finally, the section also explains applicable recordkeeping requirements (see Section 1.5) and provides guidance for licensees who wish to cancel, replace, or transfer their financial assurance mechanisms (see Section 1.6).

Note that throughout the remainder of this Appendix, the term "licensee" refers to both licensees and license applicants. This Appendix also uses the terms "financial instrument," "financial mechanism," and "financial assurance mechanism" interchangeably.

1.2 WHEN FINANCIAL ASSURANCE IS REQUIRED

This section provides guidance on when a licensee must demonstrate financial assurance for a particular license. Section 1.2.1 below discusses financial assurance requirements for *decommissioning*, which apply at the time of license application or renewal and at the end of licensed operations. Section 1.2.2 below discusses financial assurance requirements for *site control and maintenance*, which are triggered if the license is being terminated under restricted conditions.

1.2.1 Financial Assurance for Decommissioning

NRC's financial assurance requirements for decommissioning apply only to licensees authorized to possess or use certain quantities and types of licensed materials. The minimum possession or use thresholds that trigger the requirements vary, depending on the type of license and the types and quantities of materials authorized under the particular license. Licensees authorized to possess only a single isotope may use the table in Attachment 1 to this Appendix to determine whether financial assurance is required for a given activity level. Any license that authorizes the possession or use of types or quantities of materials exceeding these thresholds is subject to NRC's decommissioning financial assurance requirements. Note that the relevant quantities and types of materials are those authorized under a particular license, even if a licensee does not currently or usually possess or use these same quantities and types of materials.

Type of License	Minimum License Threshold Requiring Financial Assurance
PART 30	*Unsealed byproduct material with a half-life greater than 120 days* in amounts greater than 10^3 times the applicable quantities of Appendix B to Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^3 is

greater than 1 when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30

<u>*or*</u>

Sealed sources or plated foils with a half-life greater than 120 days in amounts greater than 10^{10} times the applicable quantities of Appendix B to Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^{10} is greater than 1 when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30

PART 40 *Source material in a readily dispersible form* exceeding 10 millicuries (mCi)

PART 70 *Unsealed special nuclear material* in amounts greater than 10^3 times the applicable quantities of Appendix B to Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^3 is greater than 1 where R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30

PART 72 *Any amount of spent fuel or high-level radioactive waste*

Licensees who exceed the minimum thresholds outlined above are required to demonstrate financial assurance for decommissioning that is acceptable to the NRC until decommissioning has been completed and the license has been terminated. License applicants must have financial assurance in place prior to the receipt of licensed materials.

1.2.2 Financial Assurance for Site Control and Maintenance (License Termination Under Restricted Conditions)

If the license is being terminated under restricted conditions pursuant to 10 CFR 20.1403, a licensee must provide financial assurance for site control and maintenance following license termination.[1] This assurance must be in place before the license is terminated, and must be sufficient to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site.

1.3 CERTIFICATION OR DECOMMISSIONING FUNDING PLAN

[1] This requirement applies to all licensees who request license termination under restricted conditions, regardless of whether decommissioning financial assurance is required.

This section applies only to financial assurance demonstrations for decommissioning prepared as part of license applications or renewals. Licensees preparing or updating financial assurance demonstrations as part of decommissioning plans should skip this section, and should review Section 18.

If financial assurance is required for a particular license (as discussed in Section 1.2), a licensee must decide whether to use a certification of financial assurance or a decommissioning funding plan (DFP), the only two options for demonstrating financial assurance.

CERTIFICATION A certification of financial assurance is a financial assurance demonstration that is based on one or more of the three amounts prescribed by regulation -- $75,000, $150,000, and $750,000. Only licensees who are not required to use a DFP may use a certification, as discussed below. The certification amount specified in the regulations is the required level of financial assurance coverage for a licensee who uses a certification.

DFP A decommissioning funding plan (DFP) is a financial assurance demonstration that is based on a site-specific cost estimate for decommissioning the licensed facility. Any licensee may use a DFP, but certain licensees *must* use a DFP, as discussed below. The amount of the facility-specific cost estimate is the required level of financial assurance coverage for a licensee who uses a DFP.

Licensees may be *required* to prepare a DFP rather than a certification depending on the type of license and the types and quantities of materials authorized under the particular license. Any license authorizing the possession or use of types or quantities of materials exceeding the following thresholds must use a DFP.[2] Note that the relevant quantities and types of materials are those authorized under a particular license, even if a licensee does not currently or usually possess or use these same quantities and types of materials. Licensees whose possession limits are stated in general terms (e.g., up to 1 Ci of any nuclide having an atomic number from 1 to 83) should submit a decommissioning funding plan or commit to limiting material quantities below the applicable financial assurance thresholds. In addition, licensees authorized to possess an unlimited quantity of material must submit a DFP.

Type of License	Minimum License Threshold Requiring Use of a DFP
PART 30	*Unsealed byproduct material with a half-life greater than 120 days* in amounts greater than 10^5 times the applicable quantities of Appendix B to Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^5 is greater than 1 when R is defined as the sum of the ratios of the

[2] Licensees who are authorized to possess only a single isotope may use the table in Attachment 1 to this Appendix to determine whether a DFP is required for a given activity level.

	quantity of each isotope to the applicable value in Appendix B to Part 30
PART 40	*Source material in a readily dispersible form* exceeding 100 mCi
PART 70	*Unsealed special nuclear material* in amounts greater than 10^5 times the applicable quantities of Appendix B to Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^5 is greater than 1 where R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30
PART 72	*Any amount of spent fuel or high-level radioactive waste*

Licensees who do *not* exceed the thresholds outlined above may use *either* a certification or a DFP. Such licensees may wish to elect use of a DFP if, for example, they wish to obtain the optimal amount of financial assurance, or because use of a site-specific cost estimate may result in a lower financial assurance coverage requirement than would use of a certification (as could happen if a single facility holds multiple licenses, each of which triggers its own certification amount).

➤ Licensees who elect to use certifications of financial assurance should refer to Section 2 of this Appendix for applicable guidance. Complete Checklist 2 (in Section 2) if using a certification.

➤ Licensees who use DFPs should refer to Section 3 of this Appendix for applicable guidance. Complete Checklist 3 (in Section 3) if using a DFP.

1.4 SELECTION OF FINANCIAL INSTRUMENT

Another major decision that a licensee must make is to identify the type of financial instrument it will use to demonstrate financial assurance. The choice of financial instrument typically depends on a number of factors, including the availability of the instrument to the licensee (i.e., whether or not the licensee is capable of obtaining it), the time and difficulty associated with establishing the instrument, the cost of the instrument, and the expected amount of time remaining before decommissioning. Because these factors can differ for different licensees, each licensee will have to identify the financial instrument that best meets its particular needs.

NRC regulations specify 13 allowable types of financial instruments that fall into one of four "methods:"

Summary of NRC Experience

NRC's experience to date is that the vast majority of licensees (on the order of 70 percent) have used a parent company guarantee, self-guarantee, letter of credit, or surety bond. Trust funds also have been used to a lesser extent, as have escrow accounts. In contrast, very few licensees have used government funds, deposits of government securities, lines of credit, insurance, or external sinking funds.

1.4.1 Method 1: Prepayment

Under *prepayment*, the licensee provides advance decommissioning funding in full (i.e., in the applicable certification amount or in the amount of the facility-specific cost estimate) using an account segregated from licensee assets and outside the licensee's administrative control. Licensees who use prepayment mechanisms generally will not need to provide additional funds at the time of decommissioning unless decommissioning costs exceed the amount of financial assurance provided. Prior to decommissioning, the funds placed in prepayment instruments can be expected to generate earnings. These earnings are payable to the licensee as long as adequate funds remain in the financial mechanism. Upon completion of decommissioning, any funds remaining in the prepayment mechanism are returned to the licensee. Prepayment instruments include the following:

TRUST

A **trust** is analogous to a special bank account that is administered by a "trustee." Trusts can be readily established using an appropriately qualified financial institution as the trustee. Trustee fees are typically taken from the earnings on the trust.

- Licensees who elect to use a trust fund should refer to Section 4 for applicable guidance.
- Licensees who use a trust fund should complete Checklist 4-A (in Section 4).

ESCROW

An **escrow** is similar to a trust for practical purposes. Escrows should be established with a financial institution serving as the "escrow agent." Escrow fees are similar to those associated with trusts, and are also frequently taken from the earnings on the account.

- Licensees who elect to use an escrow account should refer to Section 5 for applicable guidance.
- Licensees who use an escrow account should complete Checklist 5-A (in Section 5).

GOVERNMENT FUND

A **government fund** is simply a trust fund or escrow account for which a State is acting as trustee or escrow agent.

- Licensees who elect to use a government fund should refer to Section 6 for applicable guidance.
- Licensees who use a government fund should complete Checklist 6-A (in Section 6).

CERTIFICATE OF DEPOSIT

A **certificate of deposit (CD)** is a deposit of cash by a licensee into a bank for a pre-specified period of time. CDs must be accompanied by a trust, escrow, or government fund.

- ➤ Licensees who elect to use a CD should refer to Section 7 for applicable guidance.
- ➤ Licensees who use a CD should complete Checklist 7-A (in Section 7).

DEPOSIT OF GOVERNMENT SECURITIES

A **deposit of government securities** is the deposit by a licensee (into an accompanying trust fund, escrow account, or government fund) of securities backed by the Federal government or a State or local government.

- ➤ Licensees who elect to use a deposit of government securities should refer to Section 8 for applicable guidance.
- ➤ Licensees who use a deposit of government securities should complete Checklist 8-A (in Section 8).

1.4.2 Method 2: Surety, Insurance, or Guarantee

Under the surety, insurance, or guarantee method, an entity with adequate financial strength (e.g., a surety, bank, or insurer) guarantees that the required amount of funds will be available whenever needed. Unlike prepayment, this method does *not* require the full amount of decommissioning funds to be set aside by the licensee in advance. Instead, the licensee typically pays an annual fee to the provider of the guarantee. Specific surety, insurance, or guarantee instruments include the following:

SURETY BOND

A **surety bond** is a guarantee by a surety company that it will fund decommissioning if the licensee fails to do so. Licensees must pay an annual fee to the surety company to provide the bond and may have to provide substantial collateral, depending on the licensee's financial condition. Surety bonds must be accompanied by a standby trust.

- ➤ Licensees who elect to use a surety bond should refer to Section 9 for applicable guidance.
- ➤ Licensees who use a surety bond should complete Checklist 9-A (in Section 9).

LETTER OF CREDIT

A **letter of credit** is a formalized line of credit extended by a bank on behalf of a licensee. The credit may be used only to fund decommissioning. As with a surety bond, licensees who use a letter of credit must pay an annual fee to the bank and may have to provide substantial collateral depending on the licensee's financial condition. Letters of credit must be accompanied by a standby trust.

- ➤ Licensees who elect to use a letter of credit should refer to Section 10 for applicable guidance.
- ➤ Licensees who use a letter of credit should complete Checklist 10-A (in Section 10).

LINE OF CREDIT A **line of credit** is similar in many respects to a letter of credit. NRC's experience is that lines of credit have been used by licensees very rarely. This is probably because, in order to be acceptable to NRC, a line of credit must be more formalized than is common practice for the banks that provide them.

- ➤ Licensees who elect to use a line of credit should refer to Section 11 for applicable guidance.
- ➤ Licensees who use a line of credit should complete Checklist 11-A (in Section 11).

INSURANCE An **insurance policy** is a guarantee by an insurance company that it will fund decommissioning activities, whenever needed, if a licensee does not do so. Insurance must be accompanied by a standby trust.

- ➤ Licensees who elect to use insurance should refer to Section 12 for applicable guidance.
- ➤ Licensees who use insurance should complete Checklist 12-A (in Section 12).

PARENT COMPANY GUARANTEE A **parent company guarantee** is a guarantee from a licensee's corporate parent that it will fund or carry out decommissioning activities if the licensee fails to do so. The corporate parent must pass a financial test to demonstrate that it has adequate financial strength to provide the guarantee. Because of its very low cost, the parent company guarantee is usually the financial instrument of choice for licensees with corporate parents willing and able to provide such a guarantee for decommissioning.

- ➤ Licensees who elect to use a parent company guarantee should refer to Section 13 for applicable guidance.
- ➤ Licensees who use a parent company guarantee should complete Checklist 13-A (in Section 13).

SELF-GUARANTEE A **self-guarantee** is a guarantee by the licensee itself that it will fund and carry out decommissioning activities. The licensee must pass a financial test to demonstrate that it has adequate financial strength to provide the guarantee. Self-guarantees may not be used by licensees who have a corporate parent. Because of its very low cost, the self-guarantee is usually the financial instrument of choice to assure decommissioning for licensees who are able to provide such a guarantee.

- ➤ Licensees who elect to use a self-guarantee should refer to Section 14 for applicable guidance.
- ➤ Licensees who use a self-guarantee should complete Checklist 14-A (in Section 14).

1.4.3 Method 3: External Sinking Fund

An **external sinking fund** allows a licensee to *gradually* prepay for decommissioning by combining the use of a partially-funded prepayment instrument (e.g., a trust or escrow) with a surety bond, letter of credit, or insurance covering the unfunded balance. As the licensee gradually funds the prepayment instrument over time, the licensee is allowed to reduce by a corresponding amount the coverage provided by the surety bond, letter of credit, or insurance.

- ➤ Licensees who elect to use an external sinking fund should refer to Section 15 for applicable guidance.
- ➤ Licensees who use an external sinking fund should complete Checklist 15-A (in Section 15).

1.4.4 Method 4: Statement of Intent

A **statement of intent** is a commitment by a Federal, State, or local government licensee to request and obtain decommissioning funds from its funding body when necessary. Because of its very low cost, the statement of intent is usually the financial instrument of choice to assure decommissioning for government licensees. This method (and instrument) is available only to licensees who are government entities.

- ➤ Licensees who elect to use a statement of intent should refer to Section 16 for applicable guidance.
- ➤ Licensees who use a statement of intent should complete Checklist 16-A (in Section 16).

1.4.5 Standby Trust Funds

As noted earlier, funds drawn from a surety bond, letter of credit, line of credit, or insurance policy must be placed directly into a **standby trust fund** if the licensee fails to conduct decommissioning as required. A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source. Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. Standby trusts are necessary because, if the funds from surety or insurance mechanisms were paid directly to NRC rather than to a standby trust fund, NRC would be required to deposit the funds in the U.S. Treasury as general revenue. Consequently, the funds would not be available to pay for decommissioning costs.

- ➤ Licensees who elect to use a standby trust fund should refer to Section 17 for applicable guidance.
- ➤ Licensees who use a standby trust fund should complete Checklist 17-A (in Section 17).

1.4.6 Special Arrangements with a Government Entity

In cases where the license is being terminated under restricted conditions, licensees may provide financial assurance through a **special arrangement** deemed acceptable by a governmental entity when the governmental entity assumes custody and ownership of a site.[3]

- ➤ Licensees who elect to use a special arrangement with a government entity should refer to Section 18.2.2 for applicable guidance.
- ➤ Licensees who use a special arrangement with a government entity should complete Checklist 18-A (in Section 18).

1.5 RECORDKEEPING

The recordkeeping requirements for licensees are in 10 CFR 30.35(g), 40.36(f), 70.25(g), and 72.30(d). At a minimum, licensees must keep records of:

- Spills or other unusual occurrences if contamination remains after any cleanup procedure or if contaminants may have spread to inaccessible areas. These records must include information on nuclides, quantities, forms, and concentrations.
- As-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used or stored.
- Records of the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning, as well as records of the funding methods used for assuring funds.

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[3] This mechanism may only be used in a financial assurance demonstration that is submitted at the end of licensed operations.

- A copy of the financial assurance mechanism and other supporting documentation.

Timely notification should be given to the NRC in the following situations:

- Any proposed changes, revisions, and adjustments to the underlying cost estimates and to the financial mechanisms, including a change from one mechanism to another.

- Commencement of bankruptcy action involving the licensee. Written notification of commencement of bankruptcy proceedings is to be submitted, as required by 10 CFR 30.34(h), 40.41(f), 70.32(a)(9), and 72.44(b)(6).[4]

Reports that certify completion of the activities for which financial assurance is provided must be submitted before the financial assurance mechanism may be canceled.

1.6 CANCELING, REPLACING, OR TRANSFERRING FINANCIAL INSTRUMENTS

The financial assurance mechanisms outlined in this Appendix are designed so that licensees may not cancel them without NRC approval, even if a replacement instrument is being established. Licensees who wish to cancel their existing financial mechanisms must first submit a replacement to NRC for review and approval or notify NRC that decommissioning has been completed. If a replacement mechanism is provided to NRC for review, the current mechanism will *not* be canceled or released before NRC's review and approval of the replacement mechanism. Licensees should provide NRC with adequate time to review proposed replacement mechanisms. Upon NRC's approval of the replacement mechanism (or termination of the license if decommissioning has been completed), the applicable NRC Branch Chief will stamp the current mechanism "canceled," sign it, and release it to the licensee.

If the license holder is expected to change as a result of a corporate acquisition or divestiture, the licensee must obtain NRC's approval before an existing financial instrument may be transferred or released. If the new license holder intends to establish a new financial instrument to replace the existing one, NRC must approve the replacement before NRC will release the existing mechanism. NRC recommends that the licensee communicate with NRC staff concerning any replacement instrument well in advance (at least 60 days) of the scheduled change in licensee or in corporate ownership.

[4] For additional information concerning bankruptcy, licensees may refer to NUREG-1556, Volume 15, "Consolidated Guidance About Materials Licenses: Guidance About Changes of Control and About Bankruptcy Involving Byproduct, Source, or Special Nuclear Material Licenses," May 1999.

2. CERTIFICATIONS OF FINANCIAL ASSURANCE

A certification of financial assurance is a financial assurance demonstration that is based on one of the three amounts prescribed in the regulations -- $75,000, $150,000, and $750,000 -- or a combination of these amounts. For licensees who use certifications, the certification amount specified in the regulations becomes the required level of financial assurance coverage. Only certain licensees may use a certification, however, as discussed below. Licensees who use certifications must undertake the following actions, as summarized in Checklist 2.

- Determine the appropriate certification amount (see Section 2.1)
- Prepare a certification statement (see Section 2.2)
- Submit the required documentation (see Section 2.3)

Licensees using certifications eventually may have to adjust their financial assurance coverage levels (and update their financial instruments) for one of three reasons:

(1) The NRC may periodically adjust the certification amounts specified in the regulations,

(2) The licensee may elect to replace the certification with a decommissioning funding plan (DFP), or

(3) The licensee intends to initiate decommissioning and prepares a decommissioning plan.[5]

Also, regardless of a particular licensee's eligibility to use a certification amount, any licensee may elect instead to use a DFP based on a site-specific cost estimate to determine the required level of financial assurance coverage. Licensees may wish to use a DFP if, for example, they wish to obtain the optimal amount of financial assurance, or because use of certification amounts may overstate a facility's decommissioning costs (as could happen if a single facility holds multiple licenses, each of which triggers its own certification amount). Guidance on preparing DFPs is presented in Section 3 of this Appendix.

2.1 DETERMINING THE APPROPRIATE CERTIFICATION AMOUNT

Licensees may be eligible to use a particular certification amount depending on the type of license and the types and quantities of materials authorized under the particular license,

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[5] Certain licensees who notify the NRC that they will terminate activities under their licenses and decommission their facilities must submit *decommissioning plans* (not the same as decommissioning funding plans). The decommissioning plan must contain "an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning" (10 CFR 30.36(g)(4)(v), 40.42(g)(4)(v), 70.38(g)(4)(v), and 72.54(g)(5)).

CHECKLIST 2

CERTIFICATIONS OF FINANCIAL ASSURANCE

License Number(s): ______________________________

Applicable Parts of 10 CFR (check all that apply): ☐ Part 30 ☐ Part 40 ☐ Part 70 ☐ Part 72

☐ Determine the appropriate certification amount(s) (see Section 2.1)

- Amount required under Part 30 for sealed sources: ______________________
- Amount required under Part 30 for unsealed sources: ______________________
- Amount required under Part 40: ______________________
- Amount required under Part 70: ______________________
- *Total of all certification amounts for all licenses*: ______________________

☐ Prepare certification statement (see Section 2.2)

☐ Include the necessary documentation (see Section 2.3):

☐ Certification statement (see Section 2.4)
☐ Financial instrument and supporting documentation

assummarized below.[6] Note that the relevant quantities and types of materials are those *authorized* under a particular license, even if a licensee does not currently or usually possess or use these same quantities and types of materials. The following discussion of applicable certification amounts is organized into four parts corresponding to the four general license types:

- Part 30 - Byproduct Material
- Part 40 - Source Material
- Part 70 - Special Nuclear Material
- Part 72 - Independent Spent Fuel Storage Installations

2.1.1 Part 30 Certification Amounts

The following apply to the use of certification amounts by Part 30 licensees.

[6] Licensees authorized to possess only a single isotope may use the table in Attachment 1 to this Appendix to determine the appropriate certification amount for a given activity level.

- ***A certification amount of $75,000 applies*** to Part 30 licensees who are authorized to possess or use sealed sources or plated foils with a half-life greater than 120 days

  - in amounts greater than 10^{10} times the applicable quantities of Appendix B to 10 CFR Part 30 (reproduced as Attachment 2 to this Appendix) or

  - for a *combination* of isotopes, if R divided by 10^{3} is greater than 1 but if R divided by 10^{10} is greater than 1 (when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to 10 CFR Part 30).

- ***A certification amount of $150,000 applies*** to Part 30 licensees who are authorized to possess or use unsealed byproduct material

  - in amounts greater than 10^{3} but less than or equal to 10^{4} times the applicable quantities of Appendix B to 10 CFR Part 30 or

  - for a *combination* of isotopes, if R divided by 10^{3} is greater than 1 but if R divided by 10^{4} is less than or equal to 1 (when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to 10 CFR Part 30).

- ***A certification amount of $750,000 applies*** to Part 30 licensees who are authorized to possess or use unsealed byproduct material in amounts exceeding the limit applicable to the $150,000 certification amount, as stated above, but

  - in amounts greater than 10^{4} but less than or equal to 10^{5} times the applicable quantities of Appendix B to 10 CFR Part 30 or

  - for a *combination* of isotopes, if R divided by 10^{4} is greater than 1 but if R divided by 10^{5} is less than or equal to 1 (when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30).

- ***A certification amount may not be used*** for a Part 30 license authorizing the possession or use of byproduct material in amounts exceeding the limit applicable to the $750,000 certification amount, as stated above. These licensees must prepare DFPs, as discussed in Section 3.

- ***No financial assurance is required*** (as discussed in Section 1.2) for a Part 30 licensee who is authorized to possess or use (1) unsealed byproduct material in amounts less than or equal to 10^{3} times the applicable quantities of Appendix B to 10 CFR Part 30 (reproduced as Attachment 2 to this Appendix) or, for a combination of isotopes, if R divided by 10^{3} is less than or equal to 1 when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30, or (2) sealed sources or plated foils in amounts less than or equal to 10^{10} times the applicable quantities of Appendix B to 10 CFR Part 30 or, for a combination of isotopes, if R divided by 10^{10} is less than or equal to 1 when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to Part 30.

2.1.2 Part 40 Certification Amounts

The following apply to the use of certification amounts by Part 40 licensees.

- ***A certification amount of $150,000 applies*** to a Part 40 licensee who is authorized to possess or use source material in a readily dispersible form in amounts greater than 10 millicuries (mCi) but less than or equal to 100 mCi.

- ***A certification amount may not be used*** for Part 40 licensees authorized to possess or use source material in a readily dispersible form in amounts greater than 100 mCi. These licensees must prepare DFPs, as discussed in Section 3.

- ***No financial assurance is required*** (as discussed in Section 1.2) for Part 40 licensees who are authorized to possess or use source material in a readily dispersible form in amounts less than or equal to 10 mCi.

2.1.3 Part 70 Certification Amounts

The following apply to the use of certification amounts by Part 70 licensees.

- ***A certification amount of $150,000*** applies to a Part 70 licensee who is authorized to possess or use unsealed special nuclear material

  - in amounts greater than 10^3 but less than or equal to 10^4 times the applicable quantities of Appendix B to Part 30 (reproduced above) or

  - for a *combination* of isotopes, if R divided by 10^3 is greater than 1 but if R divided by 10^4 is less than or equal to 1 (when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to 10 CFR Part 30).

- ***A certification amount of $750,000*** applies to a Part 70 licensee who is authorized to possess or use unsealed special nuclear material in amounts exceeding the limit applicable to the $150,000 certification amount, as stated above, but

  - in amounts greater than 10^4 but less than or equal to 10^5 times the applicable quantities of Appendix B to 10 CFR Part 30 or

  - for a *combination* of isotopes, if R divided by 10^4 is greater than 1 but if R divided by 10^5 is less than or equal to 1 (when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to 10 CFR Part 30).

- ***A certification amount may not be used*** for a Part 70 license authorizing the possession or use of unsealed special nuclear material in amounts exceeding the limit applicable to the $750,000 certification amount, as stated above. These licensees must prepare DFPs, as discussed in Section 3.

- ***No financial assurance is required*** (as discussed in Section 1.2) for a Part 70 license authorizing the possession or use of unsealed special nuclear material in amounts less than or equal to 10^3 times the applicable quantities of Appendix B to 10 CFR Part 30 or, for a combination of isotopes, if R divided by 10^3 is less than or equal to 1 when R is defined as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix B to 10 CFR Part 30. No financial assurance is required for licensees possessing only special nuclear material in sealed form.

2.1.4 Part 72 Certification Amounts

Licensees under Part 72 are not permitted to use certifications of financial assurance. These licensees must prepare DFPs, as discussed in Section 3.

2.2 PREPARING THE CERTIFICATION STATEMENT

Licensees who use certifications of financial assurance prepare a *certification statement*. In the certification statement, the licensee certifies that it has obtained financial assurance in the appropriate certification amount and provides the details needed to verify that the certification amount is accurate under NRC regulations. As discussed above, these details include the license type and the types and amounts of materials authorized by the license.

The model wording for certification statements that is presented in Section 2.4 is acceptable to the NRC staff. Although other wording may also be satisfactory, all certification statements should clearly identify the licensee, the license number, the type of license (e.g., Part 30), the types and amounts of materials authorized by the license (including specific isotopes where applicable), the appropriate certification amount, and a certification that the information presented in the statement is accurate.

2.3 SUBMITTING THE REQUIRED DOCUMENTATION

Under NRC's financial assurance regulations, 10 CFR 30.35(b)(2), 40.36(b)(2), and 70.25(b)(2), licensees who use certifications of financial assurance must submit the following to the NRC.

- The certification statement (regulatory guidance is provided in Section 2.2) and

- An *originally signed duplicate* of the financial instruments obtained to provide financial assurance for decommissioning. This Appendix describes the allowable financial instruments first in general terms, in Section 1, and then in detail beginning in Section 4. Licensees should refer to these other sections to ensure that their financial assurance instruments and supporting documentation will be acceptable to the NRC.

In addition to submitting these materials, licensees must maintain records of the amount certified for decommissioning and the funding methods used for assuring funds (e.g., a copy of the instruments and all supporting documentation).

2.4 MODEL CERTIFICATION STATEMENT

CERTIFICATION OF FINANCIAL ASSURANCE

Principal: [Legal names and business address of licensee]

NRC license number, name and address of the facility

Issued to: U.S. Nuclear Regulatory Commission

I certify that [insert name of licensee] is licensed to possess the following types of [insert all that apply: "sealed sources or plated foils with a half-life greater than 120 days licensed under 10 CFR Part 30," "unsealed byproduct material with a half-life greater than 120 days licensed under 10 CFR Part 30," "source material in a readily dispersible form licensed under 10 CFR Part 40," and "unsealed special nuclear material licensed under 10 CFR Part 70"] in the following amounts:

Type of Material	Amount of Material

[List materials and quantities of materials noted above. For *byproduct materials* and *special nuclear materials,* list separately the type and amount of *each isotope* authorized by the license.]

I also certify that financial assurance in the amount of [insert "$75,000," "$150,000," "$750,000," or the applicable sum of these amounts] has been obtained for the purpose of decommissioning as prescribed by 10 CFR Part [insert 30, 40, or 70].

[Signatures and titles of officials of institution]

[Corporate seal]

[Date]

3. DECOMMISSIONING FUNDING PLANS

A decommissioning funding plan (DFP) is a financial assurance demonstration that is based on a *site-specific cost estimate* for decommissioning the facility. The amount of the facility-specific cost estimate becomes the minimum required level of financial assurance coverage. Any licensee may use a DFP, but certain licensees *must* use a DFP, as discussed in Section 1.

Licensees who use DFPs must undertake the following actions, as summarized in Checklist 3.

- Prepare a site-specific decommissioning cost estimate (see Section 3.1)
- Determine the means that will be used to adjust the cost estimate and associated funding levels periodically over the life of the facility (See Section 3.2)
- Submit the required documentation (see Section 3.3)

3.1 PREPARING THE SITE-SPECIFIC COST ESTIMATE

In evaluating decommissioning cost estimates, the NRC considers the following factors:

- The completeness of the estimate (i.e., scope),
- The level of detail presented, and
- The reasonableness of the estimate (i.e., the accuracy and magnitude of estimated costs).

These factors are discussed briefly below. Sections 3.1.1-3.1.3 outline or describe the three basic parts of a cost estimate: the facility description, the estimated decommissioning costs, and key assumptions. Section 3 concludes with a series of cost estimating tables that can assist licensees in preparing decommissioning cost estimates that are likely to be acceptable to the NRC.

The site-specific cost estimate required for a DFP should represent the licensee's best approximation of all direct and indirect costs of decommissioning its facilities under routine facility conditions. The assumption that routine facility conditions will prevail at the time of decommissioning implies that the cost estimate need not consider a worst-case decommissioning scenario. Similarly, however, the estimate should not be based on a scenario that is more optimistic than would be consistent with routine facility conditions. By way of example, NRC believes it reasonable for decommissioning cost estimates to assume the following:

CHECKLIST 3

DECOMMISSIONING FUNDING PLANS

License Number(s): ______________________________

Applicable Parts of 10 CFR (check all that apply): ☐ Part 30 ☐ Part 40 ☐ Part 70 ☐ Part 72

- ☐ Prepare a detailed, site-specific cost estimate (see Section 3.1)
- ☐ Determine the means that will be used to adjust the site-specific cost estimate and associated funding levels periodically over the life of the facility (see Section 3.2)
- ☐ Include the necessary documentation (see Section 3.3):
    - ☐ Detailed, site-specific cost estimate
    - ☐ Description of the means that will be used to adjust the site-specific cost estimate and associated funding level
    - ☐ A certification that financial assurance for decommissioning has been provided in the amount of the decommissioning cost estimate
    - ☐ Financial instrument and supporting documentation

- Inventories of materials and wastes at the time of decommissioning will be in amounts that are consistent with routine facility conditions over time.[7]

- Costs will be incurred to decontaminate some areas where contamination is possible but uncertain (e.g., areas that were contaminated in the past and that are cleaned up only periodically).

- Costs will be incurred for some cleanup of minor or cumulative spills that might have gone undetected under routine facility conditions before decommissioning.

- Decommissioning activities take place immediately on cessation of operations without multi-year storage-for-decay periods.

- Work will be performed by an independent third-party contractor.

[7] For example, if radioactive waste is continually generated but is not disposed until after a certain period of time (e.g., three months) has elapsed, then it is reasonable for the cost estimate to assume that, at the time of decommissioning, the facility will have an inventory of waste equal to that typically on site just prior to routine disposal (i.e., a three-month inventory).

Decommissioning activities do not need to include removal or disposal of non-radioactive structures and materials beyond that necessary to terminate the NRC license.

A decommissioning cost estimate should contain a substantial level of detail, consistent with the guidance presented in this section, to allow NRC to fully evaluate the adequacy of the estimate. A series of cost estimating tables are provided at the end of this section to assist licensees in preparing decommissioning cost estimates that contain sufficient detail and are likely to be acceptable to NRC. *The NRC staff recommends that licensees pattern their cost estimates after the cost estimating tables presented at the end of this section.*

The labor estimates, material costs, and other factors of the cost estimate should have a clear and reasonable basis. Licensees may wish to consider the use of NRC-provided cost information such as that found in NUREG/CR-6477, "Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities" (July 1998), and other NRC cost estimating references. (Other documents that may help in calculating estimates for decommissioning costs are in the Bibliography of this Appendix.)

Complete decommissioning cost estimates contain three basic parts:

(1) A facility description,
(2) The estimated decommissioning costs (including labor costs, non-labor costs, and a contingency factor), and
(3) Key assumptions.

These parts of cost estimates are discussed separately below and have been incorporated into the cost estimating tables at the end of Section 3.

3.1.1 Facility Description

The facility description provides the basic context of the estimate. It should include both general and specific information, including:

- License number and type,
- Specific quantities and types of materials authorized by the license (e.g., by specific isotope),
- General discussion of how licensed materials are used in the licensee's operations,
- Description of facility buildings, rooms, and grounds, including the number and dimensions of areas (e.g., laboratories) that require decontamination,
- Number and dimensions of facility components (e.g., fume hoods, glove boxes, laboratory benches, ductwork) that require decontamination,
- Levels of contamination, and
- Quantities of materials or waste accumulated prior to shipping or disposal (if applicable).

The facility description should also address any other characteristics of the facility that need to be understood to evaluate the estimated decommissioning costs.

3.1.2 Estimated Decommissioning Costs

The cost estimate must account for the costs of all phases of the decommissioning process. The estimate should itemize each of the major decommissioning tasks or activities and should distinguish between labor costs and non-labor costs, as described in Sections 3.1.2.1 and 3.1.2.2. The estimate should also explicitly incorporate a contingency factor as discussed in Section 3.1.2.3.

3.1.2.1 Labor Costs

Labor costs associated with all decommissioning tasks and activities should include basic wages and benefits for licensee and contractor staff performing decommissioning-related tasks, overhead costs,[8] and contractor profit (if applicable). Labor costs should be broken out by major task or activity, such as:

- Planning and preparation of the facility and site for decommissioning, including activities such as preparing a detailed decommissioning plan, preparing other State or local documentation, developing work plans, performing staff training, procuring special equipment, and characterizing the radiological condition of the facility,
- Decontamination or dismantling of radioactive facility components,
- Restoration of contaminated areas on facility grounds, if necessary,
- A final radiation survey (including sampling),
- Site stabilization and long-term surveillance, if necessary.

The cost estimate should also describe the techniques and methods that will be used to decontaminate facility components because these decontamination methods will impact the amount of labor required. If any of the decommissioning tasks or activities listed above do not apply to a particular facility, the estimate should explain why this is the case.

3.1.2.2 Non-labor Costs

Non-labor costs also are likely to arise during decommissioning, such as:

- Packing materials
- Shipping costs (these could be classified as labor costs for some facilities)

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[8] The term “overhead” typically includes costs that are not directly traceable to any particular product produced or project conducted by the firm. Thus, overhead typically includes “period” costs such as insurance, utilities, rent, supplies, property taxes, depreciation, and the costs of any wages, salaries, and benefits incurred as a result of the corporation’s officers and “support staff” (e.g., accounting staff, legal staff, janitorial staff, security staff). To spread such costs across multiple products or projects fairly, firms usually calculate an “indirect” overhead rate that is applied to all direct labor hours (i.e., on those labor hours that are directly associated with particular products or projects). Licensees should provide justification for the overhead rates assumed in the cost estimate.

- Disposal costs
- Other equipment and supplies (e.g., personal protective equipment, brushes)
- Laboratory costs (including transport of samples to a third-party laboratory, testing and analysis, etc.)
- Miscellaneous expenses (e.g., license fees, insurance, taxes).

3.1.2.3 Contingency Factor

Because of the uncertainty in contamination levels, waste disposal costs, and other costs associated with decommissioning, the cost estimate should apply a contingency factor of 25 percent to the sum of all estimated decommissioning costs. The 25 percent contingency factor provides reasonable assurance for *unforeseen* circumstances that could increase decommissioning costs, and should not be reduced or eliminated simply because foreseeable costs are low.

NRC's recommendation for the use of a 25 percent contingency factor is consistent with the analysis and guidance contained in NUREG/CR-6477, which applies a 25 percent contingency factor to all estimated costs associated with decommissioning various reference facilities.

3.1.3 Key Assumptions

Key assumptions used in the decommissioning cost estimate should be identified and adequately justified. For example, claims of low levels of contamination should be supported by test results or by adequate discussion of how the licensed materials are used throughout the facility. Unusual items, such as disposal of radioactive materials at zero costs, should be supported by relevant information (e.g., disposal agreements, contracts, or other information). In general, justifications based on "past experience" are likely to be adequate only if the past experience is relevant; therefore, the cost estimate should compare comparable decommissionings with respect to facilities, materials, processes, management, regulatory requirements, and price levels. If cost models are used, the models should be described in enough detail to determine whether they are adequate and appropriate given the characteristics of the facility.

The cost estimate should clearly state that it does not take credit for any *salvage value* that might be realized from the sale of potential assets (e.g., recovered materials or decontaminated equipment) during or after decommissioning. If estimated credits are taken for salvage value but are not fully realized at the time of decommissioning, the cost estimate (as well as the financial assurance) may be significantly low.[9]

3.2 DETERMINING THE MEANS FOR ADJUSTING THE COST ESTIMATE

Licensees who use DFPs must specify the means (i.e., the method and frequency) by which they will periodically adjust their cost estimates and associated funding levels over the life of

[9] In some instances, NRC may approve credit for salvage value based on its review of explicit documentation provided by the licensee to justify the credit.

their facilities. In general, cost estimates should be updated with the current prices of goods and services at least every five years or when the amounts or types of material at the facility change. Adjustments should be made to account for inflation, for other changes in the prices of goods and services (e.g., disposal cost increases), for changes in facility conditions or operations, and for changes in expected decommissioning procedures.

3.3 SUBMITTING THE REQUIRED DOCUMENTATION

Under NRC's financial assurance regulations (10 CFR 30.35(e), 40.36(d), 70.25(e), and 72.30(b)), licensees who use DFPs must submit the following to NRC:

- A site-specific cost estimate for decommissioning (regulatory guidance is provided in Section 3.1),

- A description of the means that will be used to adjust the site-specific cost estimate and associated funding levels periodically over the life of the facility (regulatory guidance is provided in Section 3.2),

- A certification by the licensee that financial assurance for decommissioning has been provided in the amount of the decommissioning cost estimate, and

- An *originally signed duplicate* of the financial instruments that provide financial assurance for decommissioning. This Appendix describes the allowable financial instruments in general terms in Section 1, and then in detail beginning in Section 4. Licensees should refer to these sections to ensure that their financial assurance instruments and supporting documentation will be acceptable to NRC.

In addition to submitting these materials to NRC, licensees must maintain records of these materials in their files.

3.4 FACILITY DESCRIPTION SUMMARY

NRC license numbers and types (i.e., Part 30, 40, 70, or 72)
Types and quantities of materials authorized under the licenses listed above.
Description of how licensed materials are used. (Use additional sheets as necessary)
Description of facility, including buildings, rooms, grounds, and description of where particular types of materials are used. (Use additional sheets as necessary)
Quantities of materials or waste accumulated before shipping or disposal. (Use additional sheets as necessary)

3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS

Use this table to summarize relevant features of the facility. Copy and complete the table as necessary for each room, laboratory, or area. Rooms, laboratories, or areas with similar levels of contamination may be consolidated in one table.

Name of room, laboratory, or area: ________________________________

Level of Contamination: ________________________________

Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)
Glove Boxes			
Fume Hoods			
Lab Benches			
Sinks			
Drains			
Floors			
Walls			
Ceilings			
Ventilation/Ductwork			
Hot Cells			
Equipment/Materials			
Soil Plots			
Storage Tanks			
Storage Areas			
Radwaste Areas			
Scrap Recovery Areas			
Maintenance Shop			
Equipment Decontamination Areas			
Other (specify)			

3.6 PLANNING AND PREPARATION (Work Days)

Estimate the number of work days, by specific labor category, that will be required to complete planning and preparation activities. Include all appropriate labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Activity	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________
Preparation of Documentation for Regulatory Agencies						
Submittal of Decommissioning Plan to NRC when required by 10 CFR 30.36(g)(1), 40.42(g)(1), or 70.38(g)(1)						
Development of Work Plans						
Procurement of Special Equipment						
Staff Training						
Characterization of Radiological Condition of the Facility (including sampling, soil and tailings analysis, or groundwater analysis, if applicable)						
Other (specify)						
TOTALS						

3.7 DECONTAMINATION OR DISMANTLING OF RADIOACTIVE FACILITY COMPONENTS (Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete decontamination and/or dismantling activities for each facility component. Copy and complete this table as necessary for each room, laboratory, or area. Rooms, laboratories, or areas with similar levels of contamination may be consolidated in one table.

Name of room, laboratory, or area: ______________________________
Level of Contamination: ______________________________

Component	Decon. Method	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________
Glove Boxes							
Fume Hoods							
Lab Benches							
Sinks							
Drains							
Floors							
Walls							
Ceilings							
Ventilation/Ductwork							
Hot Cells							
Equipment/Materials							
Soil Plots							
Storage Tanks							
Storage Areas							
Radwaste Areas							
Scrap Recovery Areas							
Maintenance Shop							
Equipment Decontamination Areas							
Other (specify)							
TOTALS							

3.8 RESTORATION OF CONTAMINATED AREAS ON FACILITY GROUNDS (Work Days)

Estimate the number of work days, by specific labor category, that will be required to restore contaminated areas on facility grounds.

Activity	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________
Backfill and Restore Site						
TOTALS						

3.9 FINAL RADIATION SURVEY (Work Days)

Estimate the number of work days, by specific labor category, that will be required to conduct a final radiation survey.

Activity	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________
TOTALS						

3.10 SITE STABILIZATION AND LONG-TERM SURVEILLANCE (Work Days)

Estimate the number of work days, by specific labor category, that will be required to complete site stabilization and long-term surveillance activities.

Activity	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________
TOTALS						

3.11 TOTAL WORK DAYS BY LABOR CATEGORY

Enter the total work days estimated for each specific labor category from the applicable table above (i.e., from the bottom rows of Tables 3.6 through 3.10).

Task	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________	Labor Category ________
Planning and Preparation (TOTALS from Table 3.6)						
Decontamination and/or Dismantling of Radioactive Facility Components (Sum of TOTALS from all copies of Table 3.7)						
Restoration of Contaminated Areas on Facility Grounds (TOTALS from Table 3.8)						
Final Radiation Survey (TOTALS from Table 3.9)						
Site Stabilization and Long-Term Surveillance (TOTALS from Table 3.10)						

3.12 WORKER UNIT COST SCHEDULE

Estimate labor costs (including salary, fringe benefits, and corporate overhead). Include all appropriate labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Labor Cost Component	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________
Salary & Fringe ($/year)						
Overhead Rate (%)						
Total Cost Per Year						
Total Cost Per Work Day*						

*Based on ______ work days per year (e.g., 260).

3.13 TOTAL LABOR COSTS BY MAJOR DECOMMISSIONING TASK

Multiply the estimated work days for each specific labor category (from Table 3.11) by the total cost per work day for the corresponding labor category (from Table 3.12), and enter the results in the table below. Then, add across all labor categories to determine the total labor costs for each major decommissioning task.

Task	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Labor Category** ________	**Total Labor Cost**
Planning and Preparation							
Decontamination or Dismantling of Radioactive Facility Components							
Restoration of Contaminated Areas on Facility Grounds							
Final Radiation Survey							
Site Stabilization and Long-Term Surveillance							

3.14 PACKAGING, SHIPPING, AND DISPOSAL OF RADIOACTIVE WASTES (Excluding Labor Costs)

(a) Packing Material Costs

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

Waste Type	Volume (m^3)	Number of Containers	Type of Container	Unit Cost of Container	Total Packaging Costs
TOTAL			-	-	

(b) Shipping Costs

Estimate the number of truckloads of waste to be shipped. Multiply shipping costs per mile (including truckload costs, surcharges, and overweight charges) by the total distance shipped.

Waste Type	Number of Truckloads	Unit Cost ($/mile/ truckload)	Surcharges ($/mile)	Overweight Charges ($/mile)	Distance Shipped (miles)	Total Shipping Costs
TOTAL		-	-	-	-	

(c) Waste Disposal Costs

Estimate the volume of waste to be disposed. Multiply the volume of waste disposed by the unit disposal cost (including any volume-based surcharges). Add any surcharges that are based on the number of containers of waste.

Waste Type	Disposal Volume (m^3)	Unit Cost ($\$/m^3$)	Surcharges ($\$/m^3$ or $/container)	Total Disposal Costs
TOTAL		-	-	

3.15 EQUIPMENT/SUPPLY COSTS (Excluding Containers)

Estimate the quantity of equipment and supplies required for decommissioning and multiply that quantity by the appropriate unit costs.

Equipment/Supplies	Quantity	Unit Cost	Total Equipment/Supply Cost
TOTAL	-	-	

3.16 LABORATORY COSTS

If applicable, estimate costs for analyses to be performed by an independent third-party laboratory.

Activity	Total Cost
Sampling	
Transport of samples	
Testing and analysis	
Other (specify)	
TOTAL	

3.17 MISCELLANEOUS COSTS

Estimate any other applicable costs.

Cost Item	Total Cost
License Fees	
Insurance	
Taxes	
Other (specify)	
TOTAL	

3.18 TOTAL DECOMMISSIONING COSTS

Enter the total costs reported in Tables 3.13, 3.14(a)-(c), 3.15, 3.16, and 3.17 into the appropriate cells below, and add them to obtain a subtotal. Add to the subtotal a contingency allowance in the amount of 25 percent of the subtotal to obtain the total decommissioning cost estimate. Also, calculate for each task/component the percentage it represents of the subtotal.

Task/Component	**Cost**	**Percentage**
Planning and Preparation (From Table 3.13)		
Decontamination and/or Dismantling of Radioactive Facility Components (From Table 3.13)		
Restoration of Contaminated Areas on Facility Grounds (From Table 3.13)		
Final Radiation Survey (From Table 3.13)		
Site Stabilization and Long-Term Surveillance (From Table 3.13)		
Packing Material Costs (TOTAL from Table 3.14(a))		
Shipping Costs (TOTAL from Table 3.14(b))		
Waste Disposal Costs (TOTAL from Table 3.14(c))		
Equipment/Supply Costs (TOTAL from Table 3.15)		
Laboratory Costs (TOTAL from Table 3.16)		
Miscellaneous Costs (TOTAL from Table 3.17)		
SUBTOTAL		100%
25% Contingency		
TOTAL DECOMMISSIONING COST ESTIMATE		

4. TRUST FUNDS

A *trust fund* functions much like a savings account except that (1) monies are legally segregated for a specific purpose and (2) the funds are administered by someone with a fiduciary responsibility to keep or use the property in the fund for the benefit of the beneficiary. A decommissioning trust is governed by an irrevocable, three-party written agreement in which the licensee (called the *grantor* or, less frequently, the trustor or settlor) transfers an amount of cash, securities, or other liquid assets at least equal to the cost of decommissioning to a *trustee*, such as a bank. The trustee manages the fund according to the terms of the written agreement for the benefit of the *beneficiary* (NRC).

The remainder of this section discusses the primary criteria that determine whether particular trust fund submissions will be acceptable to NRC.

- Section 4.1 describes qualifications required of the trustee.
- Section 4.2 addresses funding and the adequacy of coverage.
- Section 4.3 discusses the documentation that supports a trust fund.
- Section 4.4 presents a model trust fund submission that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees in preparing acceptable decommissioning trusts. Checklist 4-A summarizes the primary criteria used by NRC to evaluate trust funds. Checklist 4-B (which should be used only by licensees who revise or do not use the model wording for trust agreements) presents terms and conditions that are recommended for trust agreements.

4.1 QUALIFICATIONS OF THE TRUSTEE

The regulations on financial assurance for decommissioning (10 CFR 30.35(f)(2)(ii), 40.36(e)(2)(ii), 70.25(f)(2)(ii), and 72.30(c)(2)(ii)) require that the trustee be acceptable to the NRC. Acceptable trustees include appropriate State or Federal government agencies and financial institutions that have the authority to act as trustees and whose trust operations are regulated and examined by a Federal or State agency. Trust operations are regulated separately from other banking operations, and it is very common for a regulated bank not to have the authority to act as a trustee. In addition, NRC's requirement for trustees is not usually met by individuals who are not acting as a representative of a financial institution.

- The word "National" in the title of a financial institution signals that the institution is *Federally regulated*, as do the words "National Association" or the initials "N.A." following its title. To determine whether such a financial institution qualifies as an acceptable trustee, licensees should access the Federal Financial Institutions Examination Council's (FFIEC) Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

CHECKLIST 4-A

TRUST FUNDS

☐ Documentation is complete:

- ☐ 1. Trust agreement (originally signed duplicate)
- ☐ 2. Schedule A
- ☐ 3. Schedule B
- ☐ 4. Schedule C
- ☐ 5. Specimen certificate of events
- ☐ 6. Specimen certificate of resolution
- ☐ 7. Letter of acknowledgment
- ☐ 8. Receipt or statement from the trustee showing the trust's current market value
- ☐ 9. Checklist 4-B (if model trust wording is modified or not used)

☐ The trustee is qualified:

- ☐ The financial institution is regulated by a Federal or State agency.
- ☐ The financial institution has authority to act as a trustee and has trust operations that are regulated and examined by a Federal or State agency.

☐ The trust's current market value equals or exceeds the required coverage level.

Alternatively, licensees may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution (1) is Federally regulated and (2) has Federally regulated trust operations. (The OCC's home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are:

- Northeastern District Office (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

- Southeastern District Office (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

- Central District Office (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

- Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

- Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

- Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

• The word "State" in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable trustee, licensees should access the FFIEC's Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

  Alternatively, licensees may contact the applicable State banking authority and confirm that the institution (1) is State regulated, and (2) has State-regulated trust operations. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

• The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated, as are many domestic branches of foreign banks.

The licensee may need or choose to replace the current trustee with a new trustee. To be acceptable to the NRC, any successor trustee must meet the same standard as the original trustee (i.e., must be an appropriate State or Federal government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency). To ensure that the change in trustee does not negatively impact the trust, the licensee should replace the trustee only after sufficient notification (i.e., 90 days or more) has been provided to both the NRC and the current trustee.

4.2 LEVEL OF COVERAGE

A trust must at all times contain sufficient assets, valued at their *current market value*, to complete decommissioning activities.[10] Therefore, at the time the trust is established, the trust must be fully funded, with a market value at least as great as the licensee's current decommissioning cost estimate or certification amount. When submitting a trust to NRC, a licensee should also submit documentation verifying the amount in the trust (e.g., a receipt from the trustee or a fund balance statement). If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the trust fund, the licensee must either (1) revise the trust to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the trust.

In addition to being adequately funded, a trust agreement should allow the trustee access to the full level of coverage as appropriate to complete decommissioning activities. For example, in

[10] The exception to this rule is a trust fund that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

the model wording for a trust agreement, the trustee is authorized to make decommissioning payments only up to the amount listed in Schedule A to the trust agreement. If the amount listed in Schedule A is not at least as great as the NRC-approved cost estimate or certification amount, the trustee may not be able to make sufficient payments to complete decommissioning, even if there are sufficient monies in the trust.

4.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a trust are governed by a written trust agreement. The wording of a trust agreement may vary, but Section 4.4 of this Appendix is a model trust agreement that would meet NRC's requirements and is recommended by the NRC. Other documentation must also be submitted with a trust agreement. As summarized in Checklist 4-A,[11] the following documentation is to be submitted with the trust agreement.

- The *trust agreement* (along with any amendments) is the written document that specifies the terms and conditions of the trust. The wording contained in the model trust presented in Section 4.4 is acceptable to the NRC. Licensees who use other wording should refer to Checklist 4-B to ensure that the alternative wording contains all the necessary terms and conditions.

- *Schedule A* (Section 4.5) identifies the name and address of the licensee, the NRC license numbers covered by the trust, the addresses of the licensed activity, the amount of regulatory assurances demonstrated by the trust agreement, and the date on which these amounts were last adjusted and approved by NRC.

- *Schedule B* (Section 4.5) lists the property (i.e., cash, securities, or other liquid assets) used to establish the initial trust fund.

- *Schedule C* (Section 4.5) specifies the compensation to be paid by the licensee to the trustee for its services.

- The *specimen certificate of events* (Section 4.6) and the *specimen certificate of resolution* (Section 4.7) provide the format for instructing the trustee to release monies from the trust in order to fund decommissioning activities at the licensee's facility. When submitted as part of a financial assurance package, the specimen certificates should be unexecuted drafts. (Actual authorization to release funds from the trust is accomplished when completed and notarized versions of these certificates are signed by the secretary of the licensee and presented to the trustee.)

- The notarized *letter of acknowledgment* (Section 4.8) verifies the execution of the trust agreement and certifies the trustee's signature and authority to enter into the agreement.

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[11] Supporting documentation may differ for licensees who submit trusts that differ from the recommended model.

CHECKLIST 4-B

Terms and Conditions Needed in Decommissioning Trust Agreements

Use this checklist only if deviating from the wording recommended in Section 4.4.

- ☐ Execution date of trust.
- ☐ Purpose of trust (“whereas” clauses).
- ☐ Statement of licensee’s regulatory obligations as reason for the trust fund.
- ☐ Grantor or grantors (introductory paragraph).
- ☐ Trustee or trustees (introductory paragraph):
  - ☐ 1. Names and addresses; and
  - ☐ 2. Bank or corporate trustee.
- ☐ Identification of facilities (name, address, and license number) and cost estimates or certification amounts (Section 2 and Schedule A).
- ☐ Words of transfer, conveyance, and delivery in trust (Section 3).
- ☐ Description of trust property (Section 4 and Schedule B):
  - ☐ 1. Cash,
  - ☐ 2. Securities, and
  - ☐ 3. Other liquid assets.
- ☐ Additions to trust (Section 4).
- ☐ Distribution of trust principal (Section 5):
  - ☐ 1. Disbursement to licensee upon proper certification;
  - ☐ 2. Payment for activities at NRC’s direction in writing;
  - ☐ 3. Refund to grantor at NRC’s written specification upon completion of decommissioning; and
  - ☐ 4. Maximum withdrawal of funds at one time for a particular license is limited to 10 percent of the remaining funds available for that license unless NRC written approval is attached.
- ☐ Trust management (Sections 6 - 8):
  - ☐ 1. Discretionary powers;
  - ☐ 2. Fiduciary duty;
  - ☐ 3. Commingling and investment;
  - ☐ 4. Sale or exchange of trust property;
  - ☐ 5. Scope of investments;
  - ☐ 6. Express powers of trustee;
  - ☐ 7. Borrowing money and encumbering trust assets;
  - ☐ 8. Insurance (optional);
  - ☐ 9. Operation of business (optional); and
  - ☐ 10. Compromise of claims (optional).
- ☐ Taxes and expenses (Section 9).
- ☐ Annual valuation (Section 10).
- ☐ Advice of counsel (Section 11).
- ☐ Authority, compensation, and tenure of trustees (Sections 12 - 14):
  - ☐ 1. Trustee compensation (Schedule C);
  - ☐ 2. Successor trustee; and
  - ☐ 3. Instructions to trustee.
- ☐ Amendment of agreement (Section 15).
- ☐ Irrevocability and termination (Section 16).
- ☐ Immunity and indemnification (Section 17).
- ☐ Law to govern construction and operation of trust (Section 18).
- ☐ Interpretation and severability (Section 19).
- ☐ Signatures and titles.
- ☐ Acknowledgments, seals, or attestations, if necessary or desired (witness by notary public).
- ☐ Acceptance of trust by trustee or trustees (acknowledgment).

4.4 MODEL TRUST FUND AGREEMENT

TRUST AGREEMENT

TRUST AGREEMENT, the Agreement entered into as of [insert date] by and between [insert name of licensee], a [insert name of State] [insert "corporation," "partnership," or "proprietorship"], herein referred to as the "Grantor," and [insert name and address of a trustee acceptable to NRC], the "Trustee."

WHEREAS, the U.S. Nuclear Regulatory Commission (NRC), an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72]. These regulations, applicable to the Grantor, require that a holder of, or an applicant for, a materials license issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72] provide assurance that funds will be available when needed for required decommissioning activities.

WHEREAS, the Grantor has elected to use a trust fund to provide [insert "all" or "part"] of such financial assurance for the facilities identified herein;

WHEREAS, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this Agreement, and the Trustee is willing to act as trustee;

NOW, THEREFORE, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement:

(a) The term "Grantor" means the NRC licensee who enters into this Agreement and any successors or assigns of the Grantor.

(b) The term "Trustee" means the trustee who enters into this Agreement and any successor trustee.

Section 2. Costs of Decommissioning. This Agreement pertains to the costs of decommissioning the materials and activities identified in License Number [insert license number] issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72], as shown in Schedule A.

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a trust fund (the Fund) for the benefit of the NRC. The Grantor and the Trustee intend that no third party shall have access to the Fund except as provided herein.

Section 4. Payments Constituting the Fund. Payments made to the Trustee for the Fund shall consist of cash, securities, or other liquid assets acceptable to the Trustee. The Fund is established initially as consisting of the property, which is acceptable to the Trustee, described in Schedule B attached hereto. Such property and any other property subsequently transferred to the Trustee are referred to as the "Fund," together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible nor shall it undertake any responsibility for the amount of, or adequacy of the Fund, nor any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the NRC.

Section 5. Payment for Required Activities Specified in the Plan. The Trustee shall make payments from the Fund to the Grantor upon presentation to the Trustee of the following:

(a) A certificate duly executed by the Secretary of the Grantor attesting to the occurrence of the events, and in the form set forth in the attached Specimen Certificate of Events, and

(b) A certificate attesting to the following conditions:

(1) that decommissioning is proceeding pursuant to an NRC-approved plan;

(2) that the funds withdrawn will be expended for activities undertaken pursuant to that plan; and

(3) that the NRC has been given 30 days prior notice of [insert name of licensee]'s intent to withdraw funds from the trust fund.

No withdrawal from the Fund for a particular license can exceed 10 percent of the remaining funds available for that license unless NRC written approval is attached.

In addition, the Trustee shall make payments from the Fund as the NRC shall direct, in writing, to provide for the payment of the costs of required activities covered by this Agreement. The Trustee shall reimburse the Grantor or other persons as specified by the NRC from the Fund for expenditures for required activities in such amounts as the NRC shall direct in writing. In addition, the Trustee shall refund to the Grantor such amounts as the NRC specifies in writing. Upon refund, such funds shall no longer constitute part of the Fund as defined herein.

Section 6. Trust Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge its duties with respect to the Fund solely in the interest of the beneficiary and with the care, skill, prudence and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; except that:

(a) Securities or other obligations of the Grantor, or any other owner or operator of the facilities, or any of their affiliates as defined in the Investment Company Act of 1940, as amended (15 U.S.C. 80a-2(a)), shall not be acquired or held, unless they are securities or other obligations of the Federal or a State government;

(b) The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the Federal government, and in obligations of the

Federal government such as GNMA, FNMA, and FHLM bonds and certificates or State and Municipal bonds rated BBB or higher by Standard & Poor's or Baa or higher by Moody's Investment Services; and

(c) For a reasonable time, not to exceed 60 days, the Trustee is authorized to hold uninvested cash, awaiting investment or distribution, without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:

(a) To transfer from time to time any or all of the assets of the Fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other trusts participating therein; and

(b) To purchase shares in any investment company registered under the Investment Company Act of 1940 (15 U.S.C. 80a-1 et seq.), including one that may be created, managed, underwritten, or to which investment advice is rendered, or the shares of which are sold by the Trustee. The Trustee may vote such shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretion conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

(a) To sell, exchange, convey, transfer, or otherwise dispose of any property held by it, by public or private sale, as necessary to allow duly authorized withdrawals at the joint request of the Grantor and the NRC or to reinvest in securities at the direction of the Grantor;

(b) To make, execute, acknowledge, and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

(c) To register any securities held in the Fund in its own name, or in the name of a nominee, and to hold any security in bearer form or in book entry, or to combine certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, to reinvest interest payments and funds from matured and redeemed instruments, to file proper forms concerning securities held in the Fund in a timely fashion with appropriate government agencies, or to deposit or arrange for the deposit of such securities in a qualified central depository even though, when so deposited, such securities may be merged and held in bulk in the name of the nominee or such depository with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the U.S. Government, or any agency or instrumentality thereof, with a Federal Reserve Bank, but the books and records of the Trustee shall at all times show that all such securities are part of the Fund;

(d) To deposit any cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal government; and

(e) To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 10. Annual Valuation. After payment has been made into this trust fund, the Trustee shall annually, at least 30 days before the anniversary date of receipt of payment into the trust fund, furnish to the Grantor and to the NRC a statement confirming the value of the Trust. Any securities in the Fund shall be valued at market value as of no more than 60 days before the anniversary date of the establishment of the Fund. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the NRC shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to the matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting on the advice of counsel.

Section 12. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing with the Grantor. (See Schedule C.)

Section 13. Successor Trustee. Upon 90 days notice to the NRC and the Grantor, the Trustee may resign; upon 90 days notice to NRC and the Trustee, the Grantor may replace the Trustee; but such resignation or replacement shall not be effective until the Grantor has appointed a successor Trustee, the successor accepts the appointment, the successor is ready to assume its duties as trustee, and NRC has agreed, in writing, that the successor is an appropriate State or Federal government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency. The successor Trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. When the resignation or replacement is effective, the Trustee shall assign, transfer, and pay over to the successor Trustee the funds and properties then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor Trustee or for instructions. The successor Trustee shall specify the date on which it assumes administration of the trust, in a writing sent to the Grantor, the NRC, and the present Trustee, by certified mail 10 days before such change becomes effective. Any expenses incurred by the

Trustee as a result of any of the acts contemplated by this section shall be paid as provided in Section 9.

Section 14. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by such persons as are signatories to this Agreement or such other designees as the Grantor may designate in writing. The Trustee shall be fully protected in acting without inquiry in accordance with the Grantor's orders, requests, and instructions. If the NRC issues orders, requests, or instructions to the Trustee these shall be in writing, signed by the NRC or its designees, and the Trustee shall act and shall be fully protected in acting in accordance with such orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the NRC hereunder has occurred. The Trustee shall have no duty to act in the absence of such orders, requests, and instructions from the Grantor and/or the NRC, except as provided for herein.

Section 15. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee, and the NRC, or by the Trustee and the NRC if the Grantor ceases to exist. All amendments shall meet the relevant regulatory requirements of the NRC.

Section 16. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 15, this trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the NRC, or by the Trustee and the NRC if the Grantor ceases to exist. Upon termination of the trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor or its successor.

Section 17. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this trust, or in carrying out any directions by the Grantor or the NRC issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor or from the trust fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 18. This Agreement shall be administered, construed, and enforced according to the laws of the State of [insert name of State].

Section 19. Interpretation and Severability. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement. If any part of this Agreement is invalid, it shall not affect the remaining provisions which will remain valid and enforceable.

IN WITNESS WHEREOF the parties have caused this Agreement to be executed by the respective officers duly authorized and the incorporate seals to be hereunto affixed and attested as of the date first written above.

[Insert name of licensee (Grantor)]
[Signature of representative of Grantor]
[Title]

ATTEST:
[Title] [Seal]

[Insert name of Trustee]
[Signature of representative of Trustee]
[Title]

ATTEST:
[Title] [Seal]

4.5 MODEL TRUST AGREEMENT SCHEDULES

Schedule A

This Agreement demonstrates financial assurance for the following cost estimates or certification amounts for the following licensed activities:

U.S. NUCLEAR REGULATORY COMMISSION LICENSE NUMBER(S)	NAME AND ADDRESS OF LICENSEE	ADDRESS OF LICENSED ACTIVITY	COST ESTIMATES FOR REGULATORY ASSURANCES DEMONSTRATED BY THIS AGREEMENT

The cost estimates listed here were last adjusted and approved by the NRC on [insert date].

Schedule B

AMOUNT_____________

AS EVIDENCED BY______________

Schedule C

Trustee’s fees shall be $________________ per year.

4.6 MODEL SPECIMEN CERTIFICATE OF EVENTS

[Insert name and address of trustee]

Attention: Trust Division

Gentlemen:

In accordance with the terms of the Agreement with you dated _________, I, _________ , Secretary of [insert name of licensee], hereby certify that the following events have occurred:

1. [Insert name of licensee] is required to commence the decommissioning of its facility located at [insert location of facility] (hereinafter called the decommissioning).

2. The plans and procedures for the commencement and conduct of the decommissioning have been approved by the United States Nuclear Regulatory Commission, or its successor, on __________ (copy of approval attached).

3. The Board of Directors of [insert name of licensee] has adopted the attached resolution authorizing the commencement of the decommissioning.

____
Secretary of [insert name of licensee]

____
Date

4.7 MODEL SPECIMEN CERTIFICATE OF RESOLUTION

I, __________, do hereby certify that I am Secretary of [insert name of licensee], a [insert State of incorporation] corporation, and that the resolution listed below was duly adopted at a meeting of this Corporation's Board of Directors on __________, 19___.

IN WITNESS WHEREOF, I have hereunto signed my name and affixed the seal of this Corporation this ___ day of _________, 19___.

____
Secretary

RESOLVED, that this Board of Directors hereby authorizes the President, or such other employee of the Company as he may designate, to commence decommissioning activities at [insert name of facility] in accordance with the terms and conditions described to this Board of Directors at this meeting and with such other terms and conditions as the President shall approve with and upon the advice of Counsel.

4.8 MODEL LETTER OF ACKNOWLEDGMENT

STATE OF ________________

To Wit: ________________

CITY OF ________________

On this ___ day of ____________, before me, a notary public in and for the city and State aforesaid, personally appeared ____________, and she/he did depose and say that she/he is the [insert title] of ____________ [if applicable, insert ", national banking association" or ", State banking association"], Trustee, which executed the above instrument; that she/he knows the seal of said association; that the seal affixed to such instrument is such corporate seal; that it was so affixed by order of the association; and that she/he signed her/his name thereto by like order.

____
[Signature of notary public]

My Commission Expires: ____________
[Date]

5. ESCROW ACCOUNTS

A decommissioning *escrow* (or *escrow account*) is an irrevocable, three-party written agreement whereby the licensee transfers assets (i.e., cash, securities, or other liquid assets) at least equal to the cost of decommissioning to an *escrow agent*, such as a bank. The escrow agent manages the account according to the terms of the written agreement for the benefit of the *beneficiary* (NRC). An escrow account functions much like a savings account except that (1) monies are legally segregated for a specific purpose and (2) the account is administered by someone with a fiduciary responsibility to keep or use the property in the account. The purpose of an escrow account is to help execute an underlying contract. For purposes of financial assurance for decommissioning, the underlying contract is the NRC licensing agreement.

The remainder of this section discusses the primary criteria that determine whether particular escrow account submissions will be acceptable to NRC.

- Section 5.1 describes qualifications required of the escrow agent.
- Section 5.2 addresses funding and the adequacy of coverage.
- Section 5.3 discusses the documentation that supports an escrow account.
- Section 5.4 presents a model escrow account submission that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees in preparing acceptable decommissioning escrows. Checklist 5-A summarizes the primary criteria used by NRC to evaluate escrows. Checklist 5-B (which should be used only by licensees that revise or do not use the model wording for escrow agreements) presents terms and conditions that are recommended for escrow agreements.

5.1 QUALIFICATIONS OF THE ESCROW AGENT

The escrow agent should be a financial institution whose operations are regulated and examined by a Federal or State agency. This criterion is not usually met by individuals who are not acting as a representative of a financial institution.

- The word “National” in the title of a financial institution signals that the institution is *Federally regulated*, as do the words “National Association” or the initials “N.A.” following its title. To determine whether such a financial institution qualifies as an acceptable escrow agent, licensees should access the Federal Deposit Insurance Corporation’s (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution is Federally regulated. (The OCC’s home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

CHECKLIST 5-A

ESCROW ACCOUNTS

- ☐ Documentation is complete:
  - ☐ 1. Escrow agreement (originally signed duplicate)
  - ☐ 2. Specimen certificate of events
  - ☐ 3. Specimen certificate of resolution to commence decommissioning
  - ☐ 4. Certified resolution authorizing the making and performance of the escrow agreement
  - ☐ 5. Certificate of names and specimen signatures
  - ☐ 6. Receipt or statement from the escrow agent showing the escrow's current market value
  - ☐ 7. Checklist 5-B (if model escrow wording is modified or not used)
- ☐ The financial institution is regulated by a Federal or State agency.
- ☐ The escrow's current market value equals or exceeds the required coverage level.

- Northeastern District Office (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.
- Southeastern District Office (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.
- Central District Office (312-360-8800) -- IL, IN, KY, MI, OH, and WI.
- Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.
- Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.
- Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

• The word "State" in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable escrow agent, licensees should access the FDIC's Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated, as are many domestic branches of foreign banks.

The licensee may need or choose to replace the current escrow agent with a new escrow agent. Any successor escrow agent must meet the same standard as the original escrow agent (i.e., must be a financial institution whose operations are regulated and examined by a Federal or State agency). To ensure that the change in escrow agent does not negatively impact the escrow, the licensee should replace the escrow agent only after sufficient notification (90 days or more) has been provided to both the NRC and the current escrow agent.

5.2 LEVEL OF COVERAGE

An escrow must at all times contain sufficient assets, valued at their *current market value*, to complete decommissioning activities.[12] Therefore, at the time the escrow is established, the escrow must be fully funded, with a market value at least as great as the licensee's current decommissioning cost estimate or certification amount. When submitting an escrow to NRC, a licensee should submit documentation verifying the amount in the escrow (e.g., a receipt from the escrow agent or a fund balance statement). If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the escrow account, the licensee must either (1) revise the escrow to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the escrow.

5.3 RECOMMENDED DOCUMENTATION

The terms and conditions of an escrow are governed by a written escrow agreement. The wording of an escrow agreement may vary, but Section 5.4 of this Appendix is a model escrow agreement that would meet NRC's requirements and is recommended by the NRC. Other documentation must be submitted with an escrow. As summarized in Checklist 5-A,[13] the following documentation is to be submitted for use with the model escrow.

- The *escrow agreement* (along with any amendments) is the written document that specifies the terms and conditions of the escrow. The wording contained in the model escrow presented in Section 5.4 is acceptable to NRC. Licensees who use other wording should refer to Checklist 5-B to be sure that the alternative wording contains all the necessary terms and conditions.

- The *specimen certificate of events* (Section 5.5) and the *specimen certificate of resolution to commence decommissioning* (Section 5.6) provide the required format for instructing the escrow agent to release monies from the escrow in order to fund

[12] The exception to this rule is an escrow account that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

[13] Supporting documentation may differ for licensees who submit escrows that differ from the recommended model.

decommissioning activities at the licensee's facility. When submitted as part of a financial assurance package, the specimen certificates should be unexecuted drafts. (Actual authorization to release funds from the escrow is accomplished when completed and notarized versions of these certificates are signed by the secretary of the licensee and presented to the escrow agent.)

- The *certified resolution authorizing the making and performance of the escrow agreement* (Section 5.7) officially certifies that the licensee's Board of Directors has authorized the licensee to enter into the escrow agreement.

- The *certificate of names and specimen signatures* (Section 5.8) presents the names and signatures of the licensee's officers or representatives who are authorized to sign the escrow agreement and notices, instructions, and other communications under the agreement.

CHECKLIST 5-B

Terms and Conditions Needed in Decommissioning Escrow Agreements

Use this checklist only if deviating from the wording recommended in Section 5.4.

- ☐ Introduction explaining the nature of the agreement between the parties and referring to the NRC license agreement concerning the regulatory obligations of the licensee (Paragraph 1).
- ☐ Identification of the escrow agent (Paragraph 1):
  - ☐ 1. Name and address of escrow agent;
  - ☐ 2. Position of escrow agent; and
  - ☐ 3. Duties and liabilities of escrow agent.
- ☐ Identification of the name, address, and license number of the facility, corresponding estimated costs of required activities, and the amount of financial assurance provided by the escrow account (Paragraph 1).
- ☐ Recital of delivery of items placed in escrow (Paragraph 2):
  - ☐ 1. Cash,
  - ☐ 2. Securities, and
  - ☐ 3. Other liquid assets.
- ☐ Recital of conditions and terms of the escrow account (Paragraph 3).
- ☐ Terms and conditions upon which items in escrow will be disbursed (Paragraph 4):
  - ☐ 1. Disbursements to licensee upon proper certification;
  - ☐ 2. Conditions that constitute default;
  - ☐ 3. Rights of parties upon default;
  - ☐ 4. Rights and duties of escrow agent upon default;
  - ☐ 5. Persons or names or positions to which funds may be released; and
  - ☐ 6. Maximum withdrawal of funds at one time for a particular license is limited to 10 percent of the remaining funds available for that license unless NRC written approval is attached.
- ☐ Recital of irrevocability of escrow arrangement (Paragraph 5).
- ☐ Escrow agent's rights and duties (Paragraph 6).
- ☐ Annual valuation requirement (Paragraph 7).
- ☐ Successor escrow agent (Paragraph 8).
- ☐ Recital of instructions to the escrow agent (Paragraph 9).
- ☐ Compensation and expenses of escrow agent (Paragraph 10).
- ☐ Amendment of the escrow agreement (Paragraph 11).
- ☐ Termination of escrow (Paragraph 12).
- ☐ Requirement for the financial institution issuing the mechanism to notify the licensee and the NRC at least 90 days prior to cancellation or non-renewal.
- ☐ Interpretation of escrow agreement (Paragraph 13).
- ☐ Acceptance of appointment by escrow agent (Paragraph 14).
- ☐ Severability provision (Paragraph 15).
- ☐ Signatures of licensee and escrow agent.

5.4 MODEL ESCROW AGREEMENT

ESCROW AGREEMENT

Escrow Account Number ____________

Paragraph 1. Establishment of Escrow Account.

It is agreed between the parties that [insert name of licensee] has elected to establish an escrow account with [insert name, address, and position (if applicable) of escrow agent] to provide financial assurance for decommissioning of the facility(ies) in the amounts shown below:

> [For each facility for which financial assurance is provided by the escrow agreement, list facility name, address, and license number, corresponding estimated or certified decommissioning costs, and indicate amount of financial assurance provided by the escrow account.]

Paragraph 2. Description of Property in Escrow Account.

It is hereby acknowledged by the parties that [list the assets that have been delivered to the escrow agent and indicate the market value of each item] has (have) been delivered to escrow.

[Insert name of licensee] warrants to and agrees with [insert name of escrow agent] that, unless otherwise expressly set forth in this Agreement: there is no security interest in the property in the escrow account or any part thereof; no financing statement under the Uniform Commercial Code is on file in any jurisdiction claiming a security interest in or describing (whether specifically or generally) the escrow account or any part thereof; and the escrow agent shall have no responsibility at any time to ascertain whether or not any security interest exists or to file any financing statement under the Uniform Commercial Code with respect to the escrow account or any part thereof.

Paragraph 3. Conditions of Escrow Agreement.

The property described in Paragraph 2 above will remain in the escrow account created by this Agreement until one of the following two conditions has been satisfied:

(1) The conditions specified in Paragraph 4 of this Agreement have been met; or

(2) The decommissioning activities required by 10 CFR Part [insert 30, 40, 70, or 72] have been completed, the license has been terminated, the facility site is available for unrestricted use for any public or private purpose, and the escrow account has been terminated by joint notice, in writing, from [insert name of licensee] and the U.S. Nuclear Regulatory Commission (NRC), or by NRC alone if the licensee ceases to exist.

Paragraph 4. Disbursement of property in Escrow Account.

[Insert name of escrow agent] shall make payments from the escrow account upon presentation to the escrow agent of the following:

(a) A certificate duly executed by the Secretary of the [insert name of licensee] attesting to the occurrence of the events, and in the form set forth in the attached Specimen Certificate of Events, and

(b) A certificate attesting to the following conditions:

(1) that decommissioning is proceeding pursuant to an NRC-approved plan;

(2) that the funds withdrawn will be expended for activities undertaken pursuant to that plan; and

(3) that the NRC has been given 30 days prior notice of [insert name of licensee]'s intent to withdraw funds from the escrow account.

No withdrawal from the account for a particular license can exceed 10 percent of the remaining funds available for that license unless NRC written approval is attached.

In addition, [insert name of escrow agent] shall make payments from the escrow account as the NRC shall direct, in writing, to provide for the payment of the costs of the required decommissioning activities covered by this Agreement. The escrow agent shall reimburse the licensee or other persons as specified by the NRC from the escrow account for expenses for required activities in such amounts as the NRC shall direct in writing. In addition, the escrow agent shall refund to [insert name of licensee] such amounts as the NRC specifies, in writing. Upon refund, such funds shall no longer constitute part of the escrow account as described in Paragraph 2 above.

Paragraph 5. Irrevocability.

It is also agreed between the parties that this escrow became irrevocable upon delivery to [insert name of escrow agent], the escrow agent, and will remain irrevocable and in full force and effect until the occurrence of one of the conditions described in Paragraph 3 above.

Paragraph 6. Powers of the Escrow Agent.

The only power and duties of the escrow agent shall be to hold the escrow property and to invest and dispose of it in accordance with the terms of this Agreement.

Escrow Account Management

The escrow agent shall invest and reinvest the principal and income of the escrow account and keep the escrow account invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the [insert name of licensee] may communicate in writing to the escrow agent from time to time, subject, however, to the provisions of the escrow account; the escrow agent shall discharge its duties with respect to the escrow account solely in the interest of NRC and with the care, skill, prudence, and diligence, under the circumstances then prevailing, that persons of prudence, acting in like capacity and familiar with such matters, would use in the conduct of an enterprise of like character and with like aims; except that:

(a) Securities or other obligations of the licensee, or any other owner or operator of the licensed facility(ies), or any of their affiliates as defined in the Investment Company Act of 1940, as amended (15 U.S.C. 80a-2(a)), shall not be acquired or held, unless they are securities or other obligations of the Federal government;

(b) The escrow agent is authorized to invest the escrow account in time or demand deposits to the extent insured by an agency of the Federal government, and in obligations of the Federal government such as GNMA, FNMA, and FHLM bonds and certificates or State and Municipal bonds rated BBB or higher by Standard & Poor's or Baa or higher by Moody's Investment Services; and

(c) The escrow agent is authorized to hold uninvested cash, awaiting investment or distribution, for a reasonable time and without liability for the payment of interest thereon.

Express Power of the Escrow Agent

Without in any way limiting the powers and discretion conferred upon the escrow agent by other provisions of this Agreement or by law, the escrow agent is expressly authorized and empowered:

(a) To register any securities held in the escrow account in its own name and to hold any security in bearer form or in book entry or to deposit or arrange for the deposit of any securities issued by the U.S. Government, or any agency or instrumentality thereof, with a Federal Reserve bank, but the books and records of the escrow agent shall at all times show that all such securities are part of the escrow account;

(b) To deposit any cash in the escrow account in interest-bearing accounts or savings certificates to the extent insured by an agency of the Federal government; and

(c) To pay taxes, from the account, of any kind that may be assessed or levied against the escrow account and all brokerage commissions incurred by the escrow account.

Paragraph 7. Annual Valuation.

After delivery has been made into this escrow account, the escrow agent shall annually, at least 30 days before the anniversary date of receipt of the property into the escrow account, furnish to the licensee and to the NRC a statement confirming the value of the escrow account. Any securities in the account shall be valued at market value as of no more than 60 days before the anniversary date of the establishment of the escrow account. The failure of the licensee to object in writing to the escrow agent within 90 days after the statement has been furnished to the licensee shall constitute a conclusively binding assent by the licensee, barring the licensee from asserting any claim or liability against the escrow agent with respect to the matters disclosed in the statement.

Paragraph 8. Successor Escrow Agent.

Upon 90 days prior notice to the NRC and [insert name of licensee], the escrow agent may resign; upon 90 days notice to the NRC and the escrow agent, [insert name of licensee] may replace the escrow agent; provided that such resignation or replacement is not effective until the escrow agent has appointed a successor escrow agent, the successor accepts the appointment, and the successor is ready to assume its duties as escrow agent. The successor escrow agent shall have the same powers and duties as those conferred upon the escrow agent under this Agreement. When the resignation or replacement is effective, the escrow agent shall assign, transfer, and pay over to the successor the funds and properties then constituting the escrow account. If for any reason the licensee cannot or does not act in the event of the resignation of the escrow agent, the escrow agent may apply to a court of competent jurisdiction for the appointment of a successor, or for instructions. The successor escrow agent shall specify the date on which it assumes administration of the escrow account in a writing sent to the licensee, the NRC, and the current escrow agent by certified mail 10 days before the change becomes effective. Any expenses incurred by the escrow agent as a result of any of the acts contemplated by this paragraph shall be paid as provided in Paragraph 10 of this Agreement.

Paragraph 9. Instructions to the Escrow Agent.

All orders, requests, and instructions form the licensee to the escrow agent shall be in writing, signed by such persons as are signatories to this Agreement, or such other designees as the licensee or NRC may designate in writing. All orders, requests, and instructions from the NRC shall be in writing, signed by the designees of the NRC. The escrow agent shall be fully protected in acting in accordance with such orders, requests, and instructions. The escrow agent shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the licensee or NRC under this Agreement has occurred. The escrow agent shall have no duty to act in the absence of such orders, requests, and instructions from the licensee or the NRC, except as provided in this Agreement.

Paragraph 10. Compensation and Expenses of the Escrow Agent.

The fee of the escrow agent for its services in establishing the escrow account shall be $______ , payable at the time of the execution of this Agreement, to be borne by [insert name of licensee].

Expenses of the escrow agent for the administration of the escrow account, the compensation of the escrow agent for services subsequent to the establishing of the escrow account to the extent not paid directly by the licensee, and all other proper charges and disbursements shall be paid from the escrow account.

Paragraph 11. Amendment of Agreement.

This Agreement may be amended by an instrument in writing executed by the licensee, the escrow agent, and the NRC, or by the escrow agent and the NRC if the licensee ceases to exist. All amendments shall meet the relevant regulatory requirements of the NRC.

Paragraph 12. Termination.

This Agreement can be terminated by written notice of termination to the escrow agent signed by [insert name of licensee] and the NRC, or by the NRC alone if the licensee ceases to exist.

Paragraph 13. Interpretation.

This escrow agreement constitutes the entire agreement between [insert name of licensee] and [insert name of escrow agent]. The escrow agent shall not be bound by any other agreement or contract entered into by [insert name of licensee], and the only document that may be referenced in case of ambiguity in this escrow agreement is the licensing agreement between [insert name of licensee] and the United States Nuclear Regulatory Commission, or its successor.

Paragraph 14. Acceptance of Appointment by Escrow Agent.

[Insert name, address, and position (if applicable) of escrow agent] does hereby acknowledge its appointment by [insert name of licensee] to serve as escrow agent for the escrow account created under this Agreement and agrees to carry out its obligations and duties as stated in this escrow agreement.

Paragraph 15. Severability.

If any part of this Agreement is invalid, it shall not affect the remaining provisions that will remain valid and enforceable.

Paragraph 16.

This Agreement shall not become effective (and the escrow agent shall have no responsibility hereunder except to return the escrow property to the [insert name of licensee]) until the escrow agent shall have received the following and shall have advised [insert name of licensee] in writing that the same are in form and substance satisfactory to the escrow agent:

(1) A certified resolution of its Board of Directors authorizing the making and performance of this Agreement; and

(2) A certificate as to the names and specimen signatures of its officers or representatives authorized to sign this Agreement and notices, instructions, and other communications hereunder.

[Signatures and positions of the designees of the licensee and the escrow agent]

[Insert name of escrow agent]	[Insert name of licensee]
By ___________________	By ___________________
Name ___________________	Name ___________________
Title ___________________	Title ___________________

[Date]
[Witness by Notary Public]

5.5 MODEL SPECIMEN CERTIFICATE OF EVENTS

[Insert name and address of escrow agent]

Attention: Escrow Division

Gentlemen:

In accordance with the terms of the Agreement with you dated _________, I, _________ , Secretary of [insert name of licensee], hereby certify that the following events have occurred:

1. [Insert name of licensee] is required to commence the decommissioning of its facility located at [insert location of facility] (hereinafter called the decommissioning).

2. The plans and procedures for the commencement and conduct of the decommissioning have been approved by the United States Nuclear Regulatory Commission, or its successor, on __________ (copy of approval attached).

3. The Board of Directors of [insert name of licensee] has adopted the attached resolution authorizing the commencement of the decommissioning.

____
Secretary of [insert name of licensee]

____
Date

5.6 MODEL SPECIMEN CERTIFICATE OF RESOLUTION TO COMMENCE DECOMMISSIONING

I, _________________, do hereby certify that I am Secretary of [insert name of licensee], a [insert State of incorporation] corporation, and that the resolution listed below was duly adopted at a meeting of this Corporation's Board of Directors on __________, 19___.

IN WITNESS WHEREOF, I have hereunto signed my name and affixed the seal of this Corporation this ___ day of _________, 19___.

____
Secretary

RESOLVED, that this Board of Directors hereby authorizes the President, or such other employee of the Company as he may designate, to commence decommissioning activities at [insert name of facility] in accordance with the terms and conditions described to this Board of Directors at this meeting and with such other terms and conditions as the President shall approve with and upon the advice of Counsel.

5.7 MODEL CERTIFIED RESOLUTION AUTHORIZING THE MAKING AND PERFORMANCE OF THE ESCROW AGREEMENT

I, _________________, do hereby certify that I am Secretary of [insert name of licensee], a [insert State of incorporation] corporation, and that the resolution listed below was duly adopted at a meeting of this Corporation's Board of Directors on __________, 19___.

IN WITNESS WHEREOF, I have hereunto signed my name and affixed the seal of this Corporation this ___ day of _________, 19___.

____
Secretary

RESOLVED, that this Board of Directors hereby authorizes the President, or such other employee of the Company as he may designate, to enter into an escrow agreement with the [insert name of escrow agent] in accordance with the terms and conditions described to this Board of Directors at this meeting and with such other terms and conditions as the President shall approve with and upon the advice of Counsel.

5.8 MODEL CERTIFICATE OF NAMES AND SPECIMEN SIGNATURES

The individuals listed below are authorized to sign this Escrow Agreement on behalf of [insert name of licensee], and are authorized to sign any notices, instructions, and other communications made pursuant to the Agreement.

Name ______________________________________
Title ______________________________________
Signature ______________________________________

Name ______________________________________
Title ______________________________________
Signature ______________________________________

Name ______________________________________
Title ______________________________________
Signature ______________________________________

Name ______________________________________
Title ______________________________________
Signature ______________________________________

6. GOVERNMENT FUNDS

A *government fund* is a trust fund or escrow account for which a State is acting as trustee or escrow agent. To use this mechanism, a licensee and a State or State agency must agree that funds in an amount at least equal to the cost of decommissioning will be held in a special State fund or account and will be used solely to carry out decommissioning activities. The licensee must deposit the required amount of cash, securities, or other liquid assets in the special fund or account prior to beginning facility operations. If the licensee defaults, the State or State agency must arrange for the necessary decommissioning work to be completed by (1) ordering the licensee to decommission the site, (2) ordering the licensee to select a decommissioning contractor, or (3) choosing a contractor itself. (In the event that the State or State agency is unable to exercise its options, NRC must select the contractor.) The special fund or account terminates when decommissioning is complete, the license is terminated, and the facility site is available for unrestricted use for any public or private purpose.

The remainder of this section discusses the primary criteria that determine whether particular government fund submissions will be acceptable to NRC.

- Section 6.1 describes qualifications required of the State or State agency.
- Section 6.2 addresses funding and the adequacy of coverage.
- Section 6.3 discusses the documentation that supports a government fund.

This section also contains a checklist designed to assist licensees who use government funds for decommissioning. Checklist 6-A summarizes the primary criteria used by NRC to evaluate government funds.

6.1 QUALIFICATIONS OF THE STATE OR STATE AGENCY

As a State government entity, the State or State agency holding the assets in the government fund would automatically qualify as an acceptable trustee or escrow agent. However, a State or State agency must have the authority to establish special segregated funds or accounts to receive and hold funds for specified purposes.

6.2 LEVEL OF COVERAGE

A government fund must at all times contain sufficient assets, valued at their *current market value*, to complete decommissioning activities.[14] Therefore, at the time the fund or account is established, it must be fully funded, with a market value at least as great as the licensee's current decommissioning cost estimate or certification amount. When submitting a government fund to NRC, a licensee should also submit documentation verifying the amount in the fund or

[14] The exception to this rule is a government fund that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

CHECKLIST 6-A

GOVERNMENT FUNDS

- □ Documentation is complete:
  - □ 1. Either:
    - \- Trust agreement (originally signed duplicate) and all supporting documentation (see Section 4 and attach Checklist 4-A)
      <u>or</u>
    - \- Escrow agreement (originally signed duplicate) and all supporting documentation (see Section 5 and attach Checklist 5-A)
  - □ 2. List of assets deposited with the State or State agency
  - □ 3. Specification of the current market value of the assets deposited
  - □ 4. Specification of the date on which assets were transferred to the fund or account
  - □ 5. Specification of the licensee's certification amount or estimated cost of decommissioning
  - □ 6. Letter from State or State agency stating that use of funds will be restricted to covering the costs of decommissioning upon the licensee's default
  - □ 7. Checklist 4-B or 5-B (if model trust or escrow wording is modified or not used)
- □ The State or State agency has the authority to establish special segregated funds or accounts to receive and hold funds for specified purposes.
- □ The government fund's current market value equals or exceeds the required coverage level.

account (e.g., a receipt from the State or State agency, or a fund/account balance statement). If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the government fund, the licensee must either (1) revise the government fund to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the government fund.

6.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a government fund are governed by a written trust agreement or escrow agreement. The wording of a government fund may vary, but Sections 4.4 and 5.4 of this Appendix include a model trust agreement and a model escrow agreement that would meet

NRC's requirements and are recommended by the NRC. As summarized in Checklist 6-A, the following documentation is to be submitted with a government fund.

- The *trust agreement* or *escrow agreement* (along with all supporting documentation and any amendments) is the written document that specifies the terms and conditions of the government fund. The wording of the model trust and escrow agreements presented in Sections 4.4 and 5.4, respectively, is acceptable to the NRC. Licensees who use other wording should refer to Checklists 4-B or 5-B to be sure that the alternative wording contains all the necessary terms and conditions.

- A list of assets deposited with the State or State agency. The list should state the assets' current market value and the date on which the assets were transferred to the government fund.

- Documentation specifying the licensee's certification amount or estimated cost of decommissioning.

- A letter from the State or State agency stating that use of the funds will be restricted to covering the costs of decommissioning upon the licensee's default.

7. CERTIFICATES OF DEPOSIT

A *certificate of deposit (CD)* is a deposit of cash by a licensee into a bank for a specified period of time. The licensee deposits in a bank funds sufficient to cover the cost of decommissioning and receives a CD. If the licensee defaults on its decommissioning obligations, the NRC will draw on CDs used as financial assurance instruments. In addition, the licensee must establish a trust fund, escrow account, or government fund into which funds may be received if drawn from the CD in the event of default.

Both nonnegotiable and negotiable CDs may be used to fulfill decommissioning financial assurance requirements.

- If a CD is *nonnegotiable*, only the payee designated on the certificate may receive the funds from the bank when the CD reaches maturity. Consequently, the trustee of the trust, escrow agent of the escrow account, or State or State agency administering the government fund (if the State or State agency can hold funds without depositing them into general State revenues) must be named as payee and must be in possession of the CD.

- If a CD is *negotiable*, however, anyone holding the CD may receive the funds. Consequently, the trustee, the escrow agent, or the State or State agency must be in possession of the CD.

A certificate of deposit used to provide financial assurance for decommissioning should be for a limited time period so that the face value can be adjusted for inflation and for changes in decommissioning costs. Licensees may use either time or demand CDs to provide financial assurance. Time deposits are payable at a certain time, while demand deposits are payable on demand after a specified period of time (usually 30 to 90 days) has elapsed. Demand CDs allow the holder to withdraw funds at will at any time after the specified period has elapsed and, therefore, may be better suited to the contingency requirements of a decommissioning financial assurance mechanism. If time CDs are used, their value must be sufficient to cover decommissioning costs even if a penalty is incurred for withdrawal prior to the date specified on the certificates.

All CDs obtained by licensees to provide financial assurance for decommissioning must be fully insured by the Federal Deposit Insurance Corporation (FDIC). Deposits by a given entity in Federally insured banks and savings and loan institutions are insured only up to the basic total amount of $100,000. These limitations also apply to the interest earned on deposits. If the principal provided by the licensee is equal to or greater than the limit established through Federal bank insurance, the interest may remain uninsured. Thus, if a licensee is securing financial assurance of more than $100,000 using CDs, deposits should be split among several institutions so that all funds are fully insured by the FDIC. For example, if $750,000 in financial assurance coverage is required, the licensee would need to purchase at least eight CDs issued by eight different financial institutions whose total value at the time of financial assurance certification equaled $750,000.

In general, a bank issuing a CD may have a "set-off right" to the deposited funds. This refers to the ability of the bank to look to deposits it holds for the repayment of any indebtedness to the bank on the part of the depositor and to apply the debtor's deposit to these debts as they become due. To reduce the likelihood that the bank's set-off right might apply to CDs assuring decommissioning, licensees using CDs should inform the issuing bank that the certificate is being used to demonstrate financial assurance in compliance with NRC's regulatory requirements. Also, licensees using nonnegotiable CDs should name the trustee, escrow agent, or State or State agency as payee.

The remainder of this section discusses the primary criteria that determine whether particular submissions in regard to CDs will be acceptable to NRC.

- Section 7.1 describes qualifications required of the issuer.

- Section 7.2 addresses funding and the adequacy of coverage.

- Section 7.3 discusses the documentation that supports a certificate of deposit.

- Section 7.4 presents a model CD that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees who will use CDs. Checklist 7-A summarizes the primary criteria used by NRC to evaluate CDs. Checklist 7-B (which should be used only by licensees who revise or do not use the model wording for CDs) presents terms and conditions that are recommended for CDs.

7.1 QUALIFICATIONS OF THE ISSUER

Banks issuing CDs for financial assurance should be insured by the Federal Deposit Insurance Corporation (FDIC). To determine whether a bank is insured by the FDIC, licensees should access the FDIC's Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/.

Also, as noted above, a licensee must deposit CDs into a trust fund, escrow account, or government fund. Information on the qualifications of the issuers of these types of mechanisms is provided in Sections 4, 5, and 6.

7.2 LEVEL OF COVERAGE

A CD must at all times have a *current market value* (less any potential penalty for early withdrawal) that is sufficient to complete decommissioning activities.[15] If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the CD, the licensee must either (1) revise the CD to assure the higher amount or

[15] The exception to this rule is a CD that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

(2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the CD.

CHECKLIST 7-A

CERTIFICATES OF DEPOSIT

☐ Documentation is complete:

- ☐ 1. Certificate of deposit (originally signed duplicate)
- ☐ 2. Either:
  - Trust agreement (originally signed duplicate) and all supporting documentation (see Section 4 and attach Checklist 4-A)
    or
  - Escrow agreement (originally signed duplicate) and all supporting documentation (see Section 5 and attach Checklist 5-A)
    or
  - Government fund (originally signed duplicate) and all supporting documentation (see Section 6 and attach Checklist 6-A)
- ☐ 3. Specification of the current market value of the CD
- ☐ 4. Specification of the date on which the CD was transferred to the fund or account
- ☐ 5. Specification of the licensee's certification amount or estimated cost of decommissioning
- ☐ 6. Verification that the CD has been placed into the trust fund, escrow account, or government fund
- ☐ 7. Letter from State or State agency stating that use of funds will be restricted to covering the costs of decommissioning upon the licensee's default (needed *only* if a government fund is established to hold the CD)
- ☐ 8. Checklist 7-B (if model CD wording is modified or not used)
- ☐ 9. Checklist 4-B or 5-B (if model trust or escrow wording is modified or not used)

☐ The financial institution is insured by the Federal Deposit Insurance Corporation.

☐ The CD's current market value (less any potential penalty for early withdrawal) equals or exceeds the required coverage level.

7.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a CD are governed by a written certificate. The wording of a CD may vary, but Section 7.4 of this Appendix is a model CD that would meet the NRC's requirements and is recommended by the NRC. As summarized in Checklist 7-A,[16] the following documentation is to be submitted with a CD.

- The *certificate of deposit* constitutes the bank's written acknowledgment of the receipt and deposit of a sum of money, its promise of repayment, and other applicable terms and conditions. The wording of a CD may vary, but Section 7.4 of this Appendix is a model CD that is acceptable to the NRC. Licensees who use other wording should refer to Checklist 7-B to be sure that the alternative wording contains all the necessary terms and conditions.

- A *trust fund*, *escrow account*, or *government fund* must be established to hold the CD. The trust, escrow, or government fund should satisfy the criteria described in Sections 4, 5, or 6, respectively, and in Checklists 4-A, 5-A, or 6-A, respectively, of this Appendix.

- Documentation specifying (1) the current market value of the CD, (2) the date on which the CD was transferred to the trust fund, escrow account, or government fund, and (3) the licensee's certification amount or estimated cost of decommissioning.

- Verification (e.g., a letter or receipt) from the trustee, escrow agent, or State or State agency that the CD has been placed into the trust fund, escrow account, or government fund.

- A letter from the State or State agency stating that use of funds will be restricted to covering the costs of decommissioning upon the licensee's default (needed only if the CD is held in a government fund).

[16] Supporting documentation may differ for licensees who submit CDs that differ from the recommended model.

CHECKLIST 7-B

Terms and Conditions Needed in Decommissioning Certificates of Deposit

Use this checklist only if deviating from the wording recommended in Section 7.4.

- ☐ Time or demand deposit.
- ☐ Nonnegotiable or negotiable instrument:
  - ☐ If nonnegotiable, the certificate of deposit names the trustee, escrow agent, or State or State agency as payee and is in the possession of the trustee, escrow agent, or State or State agency.
  - ☐ If negotiable, the certificate of deposit is in the possession of the trustee, escrow agent, or State or State agency.
- ☐ Name and address of issuing bank.
- ☐ Number of certificate.
- ☐ Name of depositor.
- ☐ Amount of funds deposited.
- ☐ Name or position of payee or holder.
- ☐ Date of maturity.
- ☐ Rate of interest.
- ☐ Statement of licensee's regulatory obligations as reason for the CD.
- ☐ Names, addresses, and license numbers of assured facilities.
- ☐ Provision for automatic renewal.
- ☐ Limitation on withdrawal.
- ☐ Notice requirements.
- ☐ Provision governing penalty for early withdrawal in the event of default.
- ☐ Power of bank not to renew.
- ☐ The financial institution issuing the mechanism must notify the licensee and the NRC at least 90 days prior to cancellation or non-renewal.
- ☐ Deposit insurance covering all CDs obtained by the licensee.
- ☐ Signature and date.

7.4 MODEL CERTIFICATE OF DEPOSIT

[Name and address of issuing bank]

CERTIFICATE OF DEPOSIT NO. [INSERT NUMBER]

[Insert name of licensee] has deposited not subject to check _______________ Dollars ($__________) payable to the order of the [if the CD is nonnegotiable, insert the name of the trustee of the trust, the escrow agent of the escrow account, or the State or State agency administering the government fund; if the CD is negotiable, insert "holder"] in current funds [insert number not less than 30] days after the date written above, upon surrender of this certificate properly endorsed, with interest at the rate of _____ percent per annum from date to maturity only. The rate of interest payable hereunder is subject to change by the bank to such extent as may be necessary to comply with requirements of the Federal Reserve Board made from time to time pursuant to the Federal Reserve Act.

These funds are deposited for the purpose of providing financial assurance for the cost of decommissioning activities at [insert facility name(s), address(es), and license number(s)], as required under Title 10 of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72]. Accordingly, this certificate will be renewed automatically unless written notice of one of the following events is received from the U.S. Nuclear Regulatory Commission (NRC): (1) the default of the [insert name of licensee] on these obligations; (2) the termination of the facility license; or (3) the substitution of another financial assurance mechanism. In the event the NRC notifies the bank of the licensee's default, the bank shall pay the [if the CD is nonnegotiable, insert "payee"; if the CD is negotiable, insert "holder"] the full amount of this certificate plus any interest accrued thereon, for deposit into the [insert "trust fund," "escrow account," or "government fund"] established for decommissioning.

The bank will notify [insert name of licensee] and the NRC at least 90 days prior to cancellation or non-renewal of this certificate.

The deposit documented in this certificate is insured by the Federal Deposit Insurance Corporation.

[Signature of authorized representative of the issuer]

[Date]

8. DEPOSITS OF GOVERNMENT SECURITIES

A *deposit of government securities* is the deposit by a licensee (into a trust fund, an escrow account, or a government fund) of securities backed by the Federal government or a State or local government.

Procedures for receipt and possible reinvestment of interest from the securities should be established in the trust agreement (see Section 4) or escrow agreement (see Section 5) governing the deposit of the securities. The proper registrant for U.S. Treasury securities is the trustee of the trust, the escrow agent of the escrow account, or the State or State agency administering the government fund.

The deposit of government securities into a trust fund, escrow account, or government fund requires the careful attention of the trustee, escrow agent, or State or State agency with respect to the following matters:

- Proper registration and endorsements;
- Reinvesting interest payments;
- Handling instruments with varying maturity dates;
- Reinvesting funds from matured and redeemed instruments; and
- Filing proper forms in a timely fashion with the appropriate government agencies.

The remainder of this section discusses the primary criteria that determine whether particular deposit of government securities submissions will be acceptable to NRC.

- Section 8.1 describes qualifications required of the issuer.
- Section 8.2 addresses funding and the adequacy of coverage.
- Section 8.3 discusses the documentation that supports a deposit of government securities.

This section also contains a checklist designed to assist licensees who use deposits of government securities. Checklist 8-A summarizes the primary criteria used by NRC to evaluate deposits of government securities.

CHECKLIST 8-A

DEPOSITS OF GOVERNMENT SECURITIES

- ☐ Documentation is complete:
  - ☐ 1. Trust agreement (originally signed duplicate) and all supporting documentation (see Section 4 and attach Checklist 4-A)
    <u>or</u>
    Escrow agreement (originally signed duplicate) and all supporting documentation (see Section 5 and attach Checklist 5-A)
    <u>or</u>
    Government fund (originally signed duplicate) and all supporting documentation (see Section 6 and attach Checklist 6-A).
  - ☐ 2. List of securities deposited with the trustee, escrow agent, or State or State agency:
    - ☐ U.S. Treasury bills
    - ☐ U.S. Treasury notes
    - ☐ U.S. Treasury bonds
    - ☐ Government National Mortgage Association pass-through certificates (GNMAs)
    - ☐ Federal National Mortgage Association bonds (FNMAs)
    - ☐ Federal Home Loan Mortgage Corporation (FHLM) bonds
    - ☐ State or municipal bonds rated BBB or higher by Standard & Poor's, or Baa or higher by Moody's Investment Services
  - ☐ 3. Specification of the current market value of the securities deposited
  - ☐ 4. Specification of the date on which securities were transferred to the fund or account
  - ☐ 5. Specification of the licensee's certification amount or estimated cost of decommissioning
  - ☐ 6. Letter from State or State agency stating that use of funds will be restricted to covering the costs of decommissioning upon the licensee's default (needed *only* if a government fund is established to hold securities)
  - ☐ 7. Checklist 4-B or 5-B (if model trust or escrow wording is modified or not used)
- ☐ The current market value of deposited securities equals or exceeds the required coverage level.

8.1 QUALIFICATIONS OF THE ISSUER

Securities used in a deposit of government securities must be backed by the Federal government or a State or local government. Acceptable government securities include:

- U.S. Treasury bills, notes, and bonds,
- Government National Mortgage Association (GNMA) pass-through certificates,
- Mortgage-backed bonds issued by the Federal National Mortgage Association (FNMA) and the Federal Home Loan Mortgage Corporation (FHLM), and
- State or municipal bonds rated BBB or higher by Standard & Poor's, or Baa or higher by Moody's Investment Services.

Also, a licensee must deposit government securities into a trust fund, escrow account, or government fund. Information on these mechanisms is provided in Sections 4, 5, and 6.

8.2 LEVEL OF COVERAGE

A deposit of government securities must at all times contain sufficient securities, valued at their *current market value*, to complete decommissioning activities.[17] Therefore, at the time the trust fund, escrow account, or government fund is established, it must contain government securities with a market value at least as great as the licensee's current decommissioning cost estimate or certification amount. When submitting a deposit of government securities to NRC, a licensee should also submit documentation that verifies the amount in the trust fund, escrow account, or government fund (e.g., a receipt from the trustee, escrow agent, or State or State agency or an account balance statement). If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the deposit of government securities, the licensee must either (1) deposit additional government securities to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the deposit of government securities.

8.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a deposit of government securities are governed by a written trust agreement or escrow agreement. The wording of a deposit of government securities may vary, but Sections 4.4 and 5.4 of this Appendix include a model trust agreement and a model escrow agreement that would meet NRC's requirements and are recommended by the NRC. As summarized in Checklist 8-A, the following documentation is to be submitted when government securities are used.

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[17] The exception to this rule is a deposit of government securities that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

- A list of securities deposited with the trustee, escrow agent, or State or State agency (which should state their current market value and the date on which the securities were transferred to the fund or account).

- The *trust agreement* or *escrow agreement* (along with all supporting documentation and any amendments) is the written document that specifies the terms and conditions of the deposit of government securities. The wording in the model trust and escrow agreements in Sections 4.4 and 5.4, respectively, is acceptable to the NRC staff. Licensees who wish to use other wording should use Checklists 4-B or 5-B to be sure that the alternative wording contains all the necessary terms and conditions.

- Documentation specifying the licensee's certification amount or estimated cost of decommissioning.

- A letter from the State or State agency stating that the fund's use will be restricted to covering the costs of decommissioning upon the licensee's default (needed only if the securities are held in a government fund).

9. SURETY BONDS

A *payment surety bond* (or *surety bond*) is a guarantee by a surety company (or surety) that it will fund decommissioning activities if the principal (i.e., the licensee) fails to do so. In issuing a surety bond, the surety company becomes "jointly and severally" liable for the guaranteed payment, meaning that the surety assumes the licensee's obligation to fund decommissioning as its own and can be sued jointly with the licensee for the obligation. Consequently, most surety bonds include an indemnification provision that requires the principal to reimburse the surety for costs incurred in satisfaction of the principal's obligations.

A surety bond used for decommissioning financial assurance must be open-ended or, if written for a specified term (such as five years), must be renewed automatically unless, 90 days or more prior to the renewal date, the surety notifies both NRC and the licensee of its intention not to renew. A surety bond must also provide that the full face amount of the bond be paid to the beneficiary automatically prior to expiration, without proof of forfeiture, if the licensee fails to provide a replacement mechanism acceptable to the NRC within 30 days after receipt of notification of cancellation.

Funds drawn from a surety bond must be placed directly into a "standby trust fund" if the licensee fails to conduct decommissioning as required. A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as a surety bond). Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. (See Section 17 for more information on standby trust funds.)

The remainder of this section discusses the primary criteria that determine whether particular surety bond submissions will be acceptable to NRC.

- Section 9.1 describes qualifications required of the issuer (the surety company).
- Section 9.2 addresses the adequacy of coverage.
- Section 9.3 discusses the documentation that supports a surety bond.
- Section 9.4 presents a model surety bond that NRC has found to be acceptable.

This section also contains two checklists that are designed to assist licensees who wish to use surety bonds. Checklist 9-A summarizes the primary criteria used by NRC to evaluate surety bonds. Checklist 9-B (which should be used only by licensees who revise or do not use the model wording for surety bonds) presents terms and conditions that are recommended for surety bonds.

CHECKLIST 9-A

SURETY BONDS

- ☐ Documentation is complete:
  - ☐ 1. Surety bond (originally signed duplicate)
  - ☐ 2. Standby trust agreement and all supporting documentation (see Section 17 and attach Checklist 17-A)
  - ☐ 3. Copy of broker/agent's power of attorney authorizing the broker/agent to issue bonds
  - ☐ 4. Checklist 9-B (if model surety bond wording is modified or not used)
- ☐ The surety company is listed in the most recent edition of *Circular 570* for the State in which the bond was signed and has an underwriting limitation greater than or equal to the amount of the bond being used for decommissioning.
- ☐ The amount of the surety bond equals or exceeds the required coverage level.

9.1 QUALIFICATIONS OF THE ISSUER

To determine whether a surety company is qualified, licensees should consult the most recent edition of the U.S. Department of the Treasury's *Circular 570*, which is published annually on approximately July 1 and is updated periodically in the *Federal Register*. *(Circular 570* can also be found on the World Wide Web at http://www.fms.treas.gov/c570/index.html.) The surety must be listed in *Circular 570* as qualified in the State where the surety bond was signed, and the surety's underwriting limitation (also specified in *Circular 570*) must be at least as great as the level of coverage required for the license.[18]

Also, as noted above, a surety bond must be payable to a standby trust fund. Information on the qualifications of trustees of standby trusts is provided in Section 17.

[18] A surety can only exceed its underwriting limitation if it brings another surety company into the agreement to share the risk. Nevertheless, several sureties acting together may not exceed the sum of their individual underwriting limitations.

9.2 LEVEL OF COVERAGE

A surety bond must be in an amount that is at least equal to the licensee's certification amount or estimated cost of decommissioning.[19] If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the surety bond, the licensee must either (1) revise the surety bond to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the surety bond.

9.3 RECOMMENDED DOCUMENTATION

As summarized in Checklist 9-A,[20] licensees who wish to use surety bonds to provide financial assurance for decommissioning submit a copy of the surety bond and other documentation as discussed below.

- The *surety bond* (along with any riders or amendments) signed by an authorized representative from the surety company. The wording of a surety bond may vary, but Section 9.4 of this Appendix is a model surety bond that would meet NRC's requirements and is recommended by NRC. Licensees who wish to use other wording should refer to Checklist 9-B to be sure that the alternative wording contains all the necessary terms and conditions.

- A *copy of the broker/agent's power of attorney* authorizing the broker/agent to issue bonds on behalf of the surety company. The power of attorney ensures that the surety bond is enforceable.

- A *standby trust fund* must be established to receive funds from the surety bond. The standby trust fund should satisfy the criteria described in Section 17 and in Checklist 17-A of this Appendix.

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[19] The exception to this rule is a surety bond that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

[20] Supporting documentation may differ for licensees who submit surety bonds that differ from the recommended model.

CHECKLIST 9-B

Terms and Conditions Needed in Decommissioning Surety Bonds

Use this checklist only if deviating from the wording recommended in Section 9.4.

- ☐ Date of execution of bond and effective date.
- ☐ Name and address of licensee.
- ☐ Type of business organization and State of incorporation (if appropriate).
- ☐ NRC license number, identification of licensed facility(ies) (name and address), costs or required decommissioning activities.
- ☐ Identification of corporate or individual surety(ies):
  - ☐ 1. Name;
  - ☐ 2. State of incorporation; and
  - ☐ 3. Qualification in jurisdiction where facility covered by the surety bond is located.
- ☐ Designation of obligee (NRC).
- ☐ Recitation of consideration (fee paid for surety bond).
- ☐ Liability of surety:
  - ☐ 1. Penal sum;
  - ☐ 2. Limitation of liability;
  - ☐ 3. Condition(s) of liability; and
  - ☐ 4. Statement of joint and several liability.
- ☐ Statement of licensee's regulatory obligations as reason for bond.
- ☐ Scope and duration of bond:
  - ☐ 1. Restricted to single obligation;
  - ☐ 2. Continuing;
  - ☐ 3. Provisions for renewal; and
  - ☐ 4. Payable to a standby trust fund.
- ☐ Termination:
  - ☐ 1. By surety;
  - ☐ 2. By principal; and
  - ☐ 3. Effective date of termination or revocation.
- ☐ The financial institution issuing the mechanism must notify the licensee and the NRC by certified mail at least 90 days prior to cancellation or non-renewal.
- ☐ An automatic payment provision must be included that, if the licensee is unable to secure alternative financial assurance to replace the bond within 30 days of notification of cancellation, the NRC may draw upon the bond prior to cancellation.
- ☐ Adjustment of penal sum.
- ☐ Severability provision.
- ☐ Liability limit of the bond.
- ☐ Date.
- ☐ Signatures.
- ☐ Premium.

9.4 MODEL SURETY BOND

PAYMENT SURETY BOND

Date bond executed: ___________

Effective date: ___________

Principal: [Insert legal name and business address of licensee]

Type of organization: [Insert “proprietorship,” “partnership,” or “corporation”]

State of incorporation: __________ (if applicable)

NRC license number, name and address of facility, and amount for decommissioning activities guaranteed by this bond: _____________

Surety: [Insert name and business address]

Type of organization: [Insert “proprietorship,” “partnership,” or “corporation”]

State of incorporation: _____________ (if applicable)

Surety’s qualification in jurisdiction where licensed facility is located.

Surety’s bond number: ___________

Total penal sum of bond: $___________

Know all persons by these presents, that we, the Principal and Surety hereto, are firmly bound to the U.S. Nuclear Regulatory Commission (hereinafter called NRC) in the above penal sum for the payment of which we bind ourselves, our heirs, executors, administrators, successors, and assigns jointly and severally; provided that, where the Sureties are corporations acting as co-sureties, we, the Sureties, bind ourselves in such sum “jointly and severally” only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as is set forth opposite the name of such Surety; but if no limit of liability is indicated, the limit of liability shall be the full amount of the penal sum.

WHEREAS, the U.S. Nuclear Regulatory Commission, an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72], applicable to the Principal, which require that a license holder or an applicant for a facility license provide financial assurance that funds will be available when needed for facility decommissioning;

NOW, THEREFORE, the conditions of the obligation are such that if the Principal shall faithfully, before the beginning of decommissioning of each facility identified above, fund the standby trust fund in the amount(s) identified above for the facility;

Or, if the Principal shall fund the standby trust fund in such amount(s) after an order to begin facility decommissioning is issued by NRC or a U.S. District Court or other court of competent jurisdiction;

Or, if the Principal shall provide alternative financial assurance, and obtain NRC's written approval of such assurance, within 30 days after the date a notice of cancellation from the Surety is received by both the Principal and the NRC, then this obligation shall be null and void; otherwise it is to remain in full force and effect.

The Surety shall become liable on this bond obligation only when the Principal has failed to fulfill the conditions described above. Upon notification by the NRC that the Principal has failed to perform as guaranteed by this bond, the Surety shall place funds in the amount guaranteed for the facility into the standby trust fund.

The liability of the Surety shall not be discharged by any payment or succession of payments hereunder, unless and until such payment or payments shall amount in the aggregate to the penal sum of the bond, but in no event shall the obligation of the Surety hereunder exceed the amount of said penal sum.

The Surety may cancel the bond by sending notice of cancellation by certified mail to the Principal and to the NRC provided, however, that cancellation shall not occur during the 90 days beginning on the date of receipt of the notice of cancellation by both the Principal and the NRC, as evidenced by the return receipts.

The Principal may terminate this bond by sending written notice to the NRC and to the Surety 90 days prior to the proposed date of termination, provided, however, that no such notice shall become effective until the Surety receives written authorization for termination of the bond from the NRC.

The Principal and Surety hereby agree to adjust the penal sum of the bond yearly so that it guarantees a new amount, provided that the penal sum does not increase by more than 20 percent in any one year and no decrease in the penal sum takes place without the written permission of the NRC.

If any part of this agreement is invalid, it shall not affect the remaining provisions that will remain valid and enforceable.

In Witness Whereof, the Principal and Surety have executed this financial guarantee bond and have affixed their seals on the date set forth above.

The persons whose signatures appear below hereby certify that they are authorized to execute this surety bond on behalf of the Principal and Surety.

Principal

[Signatures]

[Names]

[Titles]

[Corporate seal]

Corporate Surety

[Name and address]

State of incorporation: ___________

Liability limit: $______________

[Signatures]

[Names and titles]

[Corporate seal]

[For every co-surety, provide signatures, names and titles, corporate seal, and other information in the same manner as for the Sureties above.]

Bond Premium: $________________

10. LETTERS OF CREDIT

A *letter of credit* is a formalized, written line of credit extended by a bank on behalf of a licensee. The credit may be used only by NRC and only to fund decommissioning in the event the licensee does not conduct decommissioning on its own. A letter of credit used to provide financial assurance for decommissioning must be irrevocable, meaning that it may not be canceled prior to its expiration date. Also, the arrangement requires that the licensee repay (with interest) any funds drawn from the letter of credit.

A letter of credit used for decommissioning financial assurance must be open-ended or, if written for a specified term (such as five years), must be renewed automatically unless 90 days or more prior to the renewal date, the issuing bank notifies both NRC and the licensee of its intention not to renew. A letter of credit must also provide that the full face amount of the credit be paid to the beneficiary automatically prior to expiration, without proof of forfeiture, if the licensee fails to provide a replacement mechanism acceptable to NRC within 30 days after receipt of notification of cancellation.

Funds drawn from a letter of credit must be placed directly into a “standby trust fund” if the licensee fails to conduct decommissioning as required. A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as a letter of credit). Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. (See Section 17 for more information on standby trust funds.)

The remainder of this section discusses the primary criteria that determine whether particular letter of credit submissions will be acceptable to NRC.

- Section 10.1 describes qualifications required of the issuer.
- Section 10.2 addresses the adequacy of coverage.
- Section 10.3 discusses the documentation that supports a letter of credit.
- Section 10.4 presents a model letter of credit that NRC has found to be acceptable.

This section also contains two checklists that are designed to assist licensees who wish to use letters of credit. Checklist 10-A summarizes the primary criteria used by NRC to evaluate letters of credit. Checklist 10-B (which should be used only by licensees who revise or do not use the model wording for letters of credit) presents terms and conditions that are recommended for letters of credit.

10.1 QUALIFICATIONS OF THE ISSUER

A bank issuing a letter of credit to a licensee should be a financial institution whose operations are regulated and examined by a Federal or State agency.

CHECKLIST 10-A

LETTERS OF CREDIT

- ☐ Documentation is complete:
  - ☐ 1. Letter of credit (originally signed duplicate)
  - ☐ 2. Standby trust agreement and all supporting documentation (see Section 17 and attach Checklist 17-A)
  - ☐ 3. Checklist 10-B (if model letter of credit wording is modified or not used)
- ☐ The financial institution is regulated by a Federal or State agency.
- ☐ The amount of the letter of credit equals or exceeds the required coverage level.

- The word "National" in the title of a financial institution signals that the institution is *Federally regulated*, as do the words "National Association" or the initials "N.A." following its title. To determine whether such a financial institution qualifies as an acceptable issuer of a letter of credit, licensees should access the Federal Deposit Insurance Corporation's (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution is Federally regulated. (The OCC's home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

  - Northeastern District Office (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

  - Southeastern District Office (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

  - Central District Office (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

  - Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

  - Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

- Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

• The word "State" in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable issuer of a letter of credit, licensees should access the FDIC's Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

• The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated, as are many domestic branches of foreign banks.

Also, as noted above, a letter of credit must be payable to a standby trust fund. Information on the qualifications of trustees of standby trusts is provided in Section 17.

10.2 LEVEL OF COVERAGE

A letter of credit must be in an amount that is at least equal to the licensee's certification amount or estimated cost of decommissioning.[21] If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the letter of credit, the licensee must either (1) revise the letter of credit to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the letter of credit.

10.3 RECOMMENDED DOCUMENTATION

Licensees who use letters of credit to provide financial assurance for decommissioning must submit a copy of the letter of credit and other documentation as discussed below and summarized in Checklist 10-A:[22]

- The *letter of credit* (along with any amendments) signed by an authorized representative from the issuing bank. The wording of a letter of credit may vary, but Section 10.4 of this Appendix is a model letter of credit that would meet NRC's requirements and is recommended by NRC. Licensees who use other wording should refer to Checklist 10-B to be sure that their wording contains all the necessary terms and conditions.

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[21] The exception to this rule is a letter of credit that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

[22] Supporting documentation may differ for licensees who submit letters of credit that differ from the recommended model.

- A *standby trust fund* must be established to receive funds from the letter of credit. The standby trust fund should satisfy the criteria described in Section 17 and in Checklist 17-A of this Appendix.

CHECKLIST 10-B

Terms and Conditions Needed in Decommissioning Letters of Credit

Use this checklist only if deviating from the wording recommended in Section 10.4.

- ☐ The instrument must be entitled an "irrevocable letter of credit."
- ☐ The name of the issuing financial institution must be identified on the letter of credit.
- ☐ The letter should be limited in amount.
- ☐ The letter of credit must contain a specified expiration date or be written for a definite term.
- ☐ The issuer's obligation to pay the beneficiary should arise only upon presentation of a draft or other documents specified in the letter of credit.
- ☐ The letter of credit must be automatically renewed at each expiration date unless notification by certified mail is received by NRC and the licensee at least 90 days prior to non-renewal.
- ☐ An automatic payment provision must be included that if the licensee is unable to secure alternative financial assurance to replace the letter of credit within 30 days of notification of cancellation, the NRC may draw upon the letter of credit prior to cancellation.
- ☐ Statement of licensee's regulatory obligations as reason for the letter of credit.
- ☐ The letter of credit must be payable to a standby trust.
- ☐ Notice of insolvency or violation of banking requirements.
- ☐ The bank must not be called upon to determine a question of fact or law at issue between the licensee and NRC.
- ☐ The licensee should have an unqualified obligation to reimburse the issuer for payments made under the letter of credit.
- ☐ Signature and title of officials of issuing institution (signature block).
- ☐ Date (signature block).
- ☐ Standards under which the letter of credit may be interpreted (i.e., Uniform Customs and Practice for Documentary Credits or Uniform Commercial Code).

10.4 MODEL LETTER OF CREDIT

IRREVOCABLE STANDBY LETTER OF CREDIT NO. [insert number]

This Credit Expires [insert date]

Issued To: U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir or Madam:

We hereby establish our Irrevocable Standby Letter of Credit No. ____ in your favor, at the request and for the account of [insert name and address of licensee] up to the aggregate amount of [insert dollar amount in words], U.S. dollars $____, available upon presentation of:

(1) your sight draft, bearing reference to this Letter of Credit No. ____, and

(2) your signed statement reading as follows: "I certify that the amount of the draft is payable pursuant to regulations issued under authority of the U.S. Nuclear Regulatory Commission."

This letter of credit is issued in accordance with regulations issued under the authority of the U.S. Nuclear Regulatory Commission (NRC), an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. The NRC has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72], which require that a holder of, or an applicant for, a materials license issued under 10 CFR Part [insert 30, 40, 70, or 72] provide assurance that funds will be available when needed for decommissioning.

This letter of credit is effective as of [insert date] and shall expire on [insert date at least 1 year later], but such expiration date shall be automatically extended for a period of [insert time period of at least 1 year] on [insert date] and on each successive expiration date, unless, at least 90 days before the current expiration date, we notify both you and [insert name of licensee], by certified mail, as shown on the signed return receipts. If [insert name of licensee] is unable to secure alternative financial assurance to replace this letter of credit within 30 days of notification of cancellation, the NRC may draw upon the full value of this letter of credit prior to cancellation. The bank shall give immediate notice to the applicant and the NRC of any notice received or action filed alleging (1) the insolvency or bankruptcy of the financial institution or (2) any violation of regulatory requirements that could result in suspension or revocation of the bank's charter or license to do business. The financial institution also shall give immediate notice if the bank, for any reason, becomes unable to fulfill its obligation under the letter of credit.

Whenever this letter of credit is drawn on, under and in compliance with the terms of this letter of credit, we shall duly honor such draft upon its presentation to us within 30 days, and we shall deposit the amount of the draft directly into the standby trust fund of [insert name of licensee] in accordance with your instructions.

Each draft must bear on its face the clause: “Drawn under Letter of Credit No. ____, dated ___ , and the total of this draft and all other drafts previously drawn under this letter of credit does not exceed [insert amount of letter of credit].”

[Signature(s) and title(s) of official(s) of issuing institution]

[Date]

This credit is subject to [insert “the most recent edition of the Uniform Customs and Practice for Documentary Credits, published by the International Chamber of Commerce,” or “the Uniform Commercial Code”].

11. LINES OF CREDIT

A *line of credit* is an extension of credit from a bank to a licensee. In common practice, a line of credit is less formal than a letter of credit.[20] To be acceptable to NRC for purposes of decommissioning financial assurance, however, a line of credit must be very similar to a letter of credit. The line of credit represents a binding arrangement by which the issuing party (i.e., a bank) agrees to place funds into a standby trust fund in the event of default by the licensee in the performance of decommissioning. A line of credit providing financial assurance for decommissioning must be documented in writing, irrevocable (meaning that it may not be canceled prior to its expiration date), and payable only at the request of NRC. The arrangement requires that the licensee repay (with interest) any funds drawn from the line of credit.

A line of credit used for decommissioning financial assurance must be open-ended or, if written for a specified term (such as five years), must be renewed automatically unless 90 days or more prior to the renewal date, the issuing bank notifies both NRC and the licensee of its intention not to renew. A line of credit must also provide that the full face amount of the credit be paid to the beneficiary automatically prior to expiration, without proof of forfeiture, if the licensee fails to provide a replacement mechanism acceptable to NRC within 30 days after receipt of notification of cancellation.

Funds drawn from a line of credit must be placed directly into a “standby trust fund” if the licensee fails to conduct decommissioning as required. A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as a line of credit). Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. (See Section 17 for more information on standby trust funds.)

The remainder of this section discusses the primary criteria that determine whether a particular line of credit submissions will be acceptable to NRC.

- Section 11.1 describes qualifications required of the issuer.
- Section 11.2 addresses the adequacy of coverage.
- Section 11.3 discusses the documentation that supports a line of credit.

This section also contains two checklists designed to assist licensees in preparing acceptable lines of credit. Checklist 11-A summarizes the primary criteria used by NRC to evaluate lines of credit. Checklist 11-B presents terms and conditions that are recommended for lines of credit. NRC has not yet developed model wording for a line of credit. Nevertheless, such wording would probably be similar to the wording for a model letter of credit.

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[20] Letters of credit are discussed in Section 10 of this Appendix.

CHECKLIST 11-A

LINES OF CREDIT

- ☐ Documentation is complete:
  - ☐ 1. Line of credit documentation or verification (originally signed duplicate)
  - ☐ 2. Standby trust agreement and all supporting documentation (see Section 17 and attach Checklist 17-A)
  - ☐ 3. Checklist 11-B
- ☐ The financial institution is regulated by a Federal or State agency.
- ☐ The amount of the line of credit equals or exceeds the required coverage level.

11.1 QUALIFICATIONS OF THE ISSUER

A bank issuing a line of credit to a licensee should be a financial institution whose operations are regulated and examined by a Federal or State agency.

- The word “National” in the title of a financial institution signals that the institution is *Federally regulated*, as do the words “National Association” or the initials “N.A.” following its title. To determine whether such a financial institution qualifies as an acceptable issuer of a line of credit, licensees should access the Federal Deposit Insurance Corporation’s (FDIC) Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution is Federally regulated. (The OCC’s home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

  - <u>Northeastern District Office</u> (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

  - <u>Southeastern District Office</u> (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

  - <u>Central District Office</u> (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

  - <u>Midwestern District Office</u> (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

  - <u>Southwestern District Office</u> (214-720-0656) -- AR, LA, OK, and TX.

- Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

- The word “State” in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable issuer of a line of credit, licensees should access the FDIC’s Institution Directory on the World Wide Web at http://www2.fdic.gov/structur/search/. Alternatively, licensees may contact the applicable State banking authority and confirm that the institution is State regulated. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

- The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated, as are many domestic branches of foreign banks.

Also, as noted above, a line of credit must be payable to a standby trust fund. Information on the qualifications of trustees of standby trusts is provided in Section 17.

11.2 LEVEL OF COVERAGE

A line of credit must be in an amount that is at least equal to the licensee’s certification amount or estimated cost of decommissioning.[21] If the licensee’s certification amount or estimated decommissioning cost increases to a level above the amount assured by the line of credit, the licensee must either (1) revise the line of credit to assure the higher amount, or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the line of credit.

11.3 RECOMMENDED DOCUMENTATION

Licensees who use lines of credit to provide financial assurance for decommissioning must submit documentation or verification of the line of credit and other documentation as discussed below and summarized in Checklist 11-A.

- *Documentation or verification of the line of credit* (along with any amendments) signed by an authorized representative from the issuing bank. Licensees should refer to Checklist 11-B to ensure that the line of credit contains all the necessary terms and conditions.

[21] The exception to this rule is a line of credit that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

- A *standby trust fund* must be established to receive funds from the line of credit. The standby trust fund should satisfy the criteria described in Section 17 and in Checklist 17-A of this Appendix.

CHECKLIST 11-B

Terms and Conditions Needed in Decommissioning Lines of Credit

- ☐ Statement of licensee's regulatory obligation as reason for the line of credit.
- ☐ The line of credit should be limited in amount.
- ☐ The line of credit must be either open-ended or renewed automatically.
- ☐ NRC may draw on the line of credit upon commencement of required activities.
- ☐ The financial institution must be obligated to provide funds without reservation as necessary for required activities.
- ☐ The issuer's obligation to pay the beneficiary should arise only upon presentation of a draft or other documents specified in the line of credit.
- ☐ The financial institution issuing the mechanism must notify the licensee and NRC by certified mail at least 90 days prior to cancellation or non-renewal.
- ☐ An automatic payment provision must be included that if the licensee is unable to secure alternative financial assurance to replace the line of credit within 30 days of notification of cancellation, then NRC may draw upon the line of credit prior to cancellation.
- ☐ The line of credit must be payable to a standby trust.
- ☐ The financial institution must not be called upon to determine a question of fact or law at issue between the licensee and NRC.
- ☐ The licensee should have an unqualified obligation to reimburse the issuer for payments made under the line of credit.
- ☐ Signatures and titles (signature block).
- ☐ Date (signature block).

12. INSURANCE POLICIES

A decommissioning *insurance policy* is a guarantee by an insurance company to fund decommissioning. An insurance policy used for decommissioning financial assurance must be open-ended or, if written for a specified term (such as five years), must be renewed automatically unless 90 days or more prior to the renewal date, the issuer notifies both NRC and the licensee of its intention not to renew. An insurance policy must also provide that the full face amount of the policy be paid to the beneficiary automatically prior to expiration, without proof of forfeiture, if the licensee fails to provide a replacement mechanism acceptable to NRC within 30 days after receipt of notification of cancellation.

Funds drawn from an insurance policy must be placed directly into a "standby trust fund" if the licensee fails to conduct decommissioning as required. A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as an insurance policy). Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. (See Section 17 for more information on standby trust funds.)

The remainder of this section discusses the primary criteria that determine whether particular insurance policy submissions will be acceptable to NRC.

- Section 12.1 describes qualifications required of the issuer (the insurance company).
- Section 12.2 addresses the adequacy of coverage.
- Section 12.3 discusses the documentation that supports an insurance policy.

This section also contains two checklists designed to assist licensees in preparing acceptable insurance policies. Checklist 12-A summarizes the primary criteria used by NRC to evaluate insurance policies. Checklist 12-B presents terms and conditions that are recommended for insurance policies. NRC has not yet developed model insurance policy wording that is acceptable to insurers and to NRC.

12.1 QUALIFICATIONS OF THE ISSUER

An insurance company that issues a policy to provide financial assurance for decommissioning must be licensed by State regulatory authorities to transact business as an insurer in one or more U.S. States. This standard prevents licensees from using policies issued by insurers that are not subject to oversight by at least one U.S. State regulatory authority. Insurance policies issued by "captive" insurers (insurers owned by at least one of the parties for which they provide coverage) may not be used by licensees to provide financial assurance for decommissioning.[22]

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[22] Captive insurers (1) are less strictly regulated than commercial insurers, (2) may not be monitored closely after their operations have been approved, and (3) usually do not have access to guarantee funds that pay claims in the event the insurer is not able to do so.

CHECKLIST 12-A

INSURANCE POLICIES

- ☐ Documentation is complete:
  - ☐ 1. Insurance policy (originally signed duplicate)
  - ☐ 2. Standby trust agreement and all supporting documentation (see Section 17 and attach Checklist 17-A)
  - ☐ 3. Checklist 12-B
- ☐ The insurance company is licensed by State regulatory authorities to transact business as an insurer in one or more U.S. States.
- ☐ The amount of the insurance policy equals or exceeds the required coverage level.

To determine whether a particular insurer is qualified, licensees should contact the State insurance commission for the State in which the insurer is located, or the National Association of Insurance Commissioners (NAIC) at (816) 842-3600 or www.naic.org, and confirm that the insurer is licensed by a State regulatory authority to transact business as an insurer in one or more U.S. States.

Also, as noted above, an insurance policy must be payable to a standby trust fund. Information on the qualifications of trustees of standby trusts is provided in Section 17.

12.2 LEVEL OF COVERAGE

An insurance policy used as a decommissioning financial assurance mechanism must provide coverage that is at least equal to the licensee's certification amount or estimated cost of decommissioning.[23] Note that an annuity policy that would gradually increase coverage over time to equal decommissioning costs would *not* be acceptable (unless accompanied by some other financial assurance mechanism to make up any shortfall). If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the insurance policy, the licensee must either (1) revise the insurance policy to assure the higher amount or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the insurance policy.

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[23] The exception to this rule is an insurance policy that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

12.3 RECOMMENDED DOCUMENTATION

Licensees who use insurance policies to provide financial assurance for decommissioning must submit a copy of the insurance policy and other documentation as discussed below and summarized in Checklist 12-A.

- A copy of the *insurance policy* (along with any endorsements or amendments) signed by an authorized representative from the insurance company. Licensees should refer to Checklist 12-B to be sure that the insurance policy contains all the necessary terms and conditions.[24]

- A *standby trust fund* must be established to receive funds from the insurance policy. The standby trust fund should satisfy the criteria described in Section 17 and in Checklist 17-A of this Appendix.

CHECKLIST 12-B

Terms and Conditions Needed in Decommissioning Insurance Policies

- ☐ Name and address of licensee.
- ☐ NRC license number; name and address of facility.
- ☐ Name and address of insurer.
- ☐ Amount of insurance policy (limit of liability).
- ☐ Premium.
- ☐ Effective date of policy.
- ☐ Expiration date of policy.
- ☐ Statement of licensee's regulatory obligations as reason for policy.
- ☐ The insurance policy must be either open-ended or renewed automatically.
- ☐ The insurer issuing the mechanism must notify the licensee and NRC by certified mail at least 90 days prior to cancellation or non-renewal.
- ☐ An automatic payment provision must be included that, if the licensee is unable to secure alternative financial assurance to replace the policy within 30 days of notification of cancellation, the NRC may draw upon the policy prior to cancellation.
- ☐ The insurance policy must be payable to a standby trust.
- ☐ Signatures.
- ☐ Date.

[24] Licensees should also maintain in their records any *certificates of insurance* signed by individuals authorized to act for the licensee and the insurer. Certificates of insurance can be helpful in clarifying any ambiguities that may exist in the insurance policy.

13. PARENT COMPANY GUARANTEES

A *parent company guarantee* is a guarantee from a licensee's corporate parent that it will fund or carry out decommissioning activities if the licensee fails to do so. The corporate parent must annually pass (within 90 days after the close of each succeeding fiscal year) one of two financial tests specified in Appendix A to 10 CFR Part 30 to demonstrate that it has adequate financial strength to provide the guarantee.[25] The financial test alternatives (see below) consider accounting ratios, net worth, assets, and bond rating data relative to fixed criteria. Also, the parent company's financial statements must have been prepared in accordance with generally accepted accounting principles applicable to the United States, and an independent certified public accountant must have verified the accuracy of the financial test data relative to the audited financial statements. A parent company guarantee may not be used in combination with other financial assurance mechanisms.

A parent company guarantee must remain in force unless the parent company sends notice of cancellation by certified mail to both NRC and the licensee at least 120 days in advance (as evidenced by the return receipts). However, a parent company guarantee may be used only as long as the parent company meets the financial test criteria. If the parent company no longer passes the financial test, it must provide alternative financial assurance if the licensee does not do so.

If the guarantee is drawn upon because the licensee fails to carry out decommissioning, the parent company must either fund or carry out decommissioning activities. Under the funding option, funds drawn from a parent company guarantee should be placed directly into a "standby trust fund." A standby trust fund is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as a parent company guarantee). Funds in the standby trust would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. (See Section 17 for more information on standby trust funds.)

The remainder of this section discusses the primary criteria that determine whether particular parent company guarantee submissions will be acceptable to NRC.

- Section 13.1 describes qualifications required of the parent company guarantor.
- Section 13.2 addresses the adequacy of coverage.
- Section 13.3 discusses the documentation that supports a parent company guarantee.
- Section 13.4 presents a model parent company guarantee that NRC has found to be acceptable.

[25] The financial tests specified in Appendix A to 10 CFR Part 30 also apply to licensees regulated under 10 CFR Parts 40, 70, and 72.

CHECKLIST 13-A

PARENT COMPANY GUARANTEES

- □ Documentation is complete:
  - □ 1. Parent company (corporate) guarantee agreement (originally signed duplicate)
  - □ 2. Letter from chief executive officer of <u>licensee</u>
  - □ 3. Letter from chief financial officer of <u>parent company</u>, including parent company guarantee financial test (Financial Test I or II)
  - □ 4. Auditor's special report confirming CFO letter and reconciling amounts in the CFO letter with parent company's financial statements
  - □ 5. Parent company's audited financial statements for the most recent fiscal year, including the auditor's opinion on the financial statements
  - □ 6. Standby trust agreement and all supporting documentation (see Section 17 and attach Checklist 17-A)
  - □ 7. Checklist 13-B (if model parent company guarantee wording is modified or not used)
- □ The corporate parent has majority control of the licensee's voting stock (if not, details on the parent-subsidiary relationship have been submitted to NRC for review).
- □ The amount of the parent company guarantee equals or exceeds the required coverage level.

This section also contains two checklists designed to assist licensees in preparing acceptable parent company guarantees. Checklist 13-A summarizes the primary criteria used by NRC to evaluate parent company guarantees. Checklist 13-B (which should be used only by licensees that revise or do not use the model wording for parent company guarantees) presents terms and conditions that are recommended for parent company guarantees.

13.1 QUALIFICATIONS OF THE PARENT COMPANY GUARANTOR

A parent company guarantee must be provided by the corporate parent of the licensee. Normally, the parent company must have majority control of the licensee's voting stock (although NRC may consider exceptions to this rule on a case-by-case basis). To qualify to provide the guarantee, the parent company must meet one of the two financial tests specified in Appendix A to 10 CFR Part 30. These two financial tests, shown below, differ in that one includes a bond rating criterion while the other does not. Parent companies without an actual bond rating may still use the bond rating alternative of the financial test by obtaining a so-called "indicative" bond rating from either Standard & Poor's or Moody's. Indicative bond ratings, which are available for a fee, are for information only and are provided as an indication of what a rating would be if the firm were to issue debt. A parent

Financial Test I

The parent company must have:

(i) Two of the following three ratios: A ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5; and
(ii) Net working capital and tangible net worth each at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used); and
(iii) Tangible net worth of at least $10 million; and
(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used).

Financial Test II

The parent company must have:

(i) A current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard & Poor's, or Aaa, Aa, A, or Baa as issued by Moody's; and
(ii) Tangible net worth at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used); and
(iii) Tangible net worth of at least $10 million; and
(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates (or prescribed amount if a certification is used).

(**Note**: Ratings of BBB- by S&P and Baa3 by Moody's are <u>not</u> sufficient to pass the parent company guarantee financial test because they are below the BBB and Baa ratings required under 10 CFR Part 30, Appendix A.)

company seeking to use an indicative bond rating should submit the rating and name of the rating service as part of the financial test demonstration. In this case, however, the company would not be able to provide NRC with information on the dates of issuance and maturity of the bond, nor would it be able to certify that the rating pertained to its "most recent bond issuance." Rather, the parent company would explain that the rating is an indicative rating. The parent company would also update the indicative rating every year as it repeats the passage of the financial test.

For purposes of the financial test, bond ratings must apply to outstanding, rated bonds that are not secured by insurance, a letter of credit, or other collateral or guarantee. The bonds must also have been issued by the parent company *directly*, rather than by any other entity.

As noted above, a parent company guarantee should be payable to a standby trust fund. Information on the qualifications of trustees of standby trusts is provided in Section 17.

13.2 LEVEL OF COVERAGE

A parent company guarantee must be in an amount that is at least equal to the licensee's certification amount or estimated cost of decommissioning. If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the parent company guarantee, the licensee must revise the guarantee to assure the higher amount (or must replace the guarantee with a different financial assurance mechanism that is in the amount of the new coverage level).[26]

13.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a parent company guarantee are governed by a written guarantee agreement. The wording of a parent company guarantee agreement may vary, but Section 13.10 of this Appendix is a model parent company guarantee agreement that would meet NRC's requirements and is recommended by NRC. Other documentation that is to be submitted with a parent company guarantee includes the following and is summarized in Checklist 13-A.[27]

- The *guarantee agreement* is the written document that specifies the terms and conditions of the parent company guarantee. The wording in the model guarantee presented in Section 13.10 is acceptable to NRC. Licensees who use other wording should refer to Checklist 13-B to be sure that the alternative wording contains all the necessary terms and conditions.

- The *chief executive officer (CEO) letter* (Section 13.4) is a letter from the CEO of the licensee that (1) certifies that the licensee is a going concern, (2) identifies the amount of the licensee's tangible net worth, (3) specifies whether the licensee is required to file a Form 10-K with the U.S. Securities and Exchange Commission, and (4) states the date on which the licensee's fiscal year ends.

- The *chief financial officer (CFO) letter* (Section 13.5) is a letter from the CFO of the parent company that (1) identifies the names, addresses, license numbers, and estimated decommissioning costs of the facilities covered by the guarantee and (2) demonstrates the parent company's ability to pass either of the two financial tests specified in Appendix A to 10 CFR Part 30. The parent company must pass the financial test for all costs covered by a financial test. These include costs covered by (1) the parent company guarantee, (2) other NRC or Agreement State parent company guarantees or self-guarantees, and (3) parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA).

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[26] Because a parent company guarantee may not be used in combination with any other financial assurance mechanism, licensees do not have the option of obtaining another mechanism to make up differences between increased coverage levels and guaranteed amounts.

[27] Supporting documentation may differ for licensees who submit parent company guarantees that differ from the recommended model.

- The *auditor's special report* (Section 13.8) is a report from the parent company's independent certified public accountant that compares the data used by the parent company in the financial test demonstration with the amounts in its annual financial statements. If needed, this report may also include a *schedule attachment* (Section 13.9) reconciling the financial test numbers with amounts in the parent company's financial statements.

- A copy of the parent company's *audited financial statements* for the most recent completed fiscal year. These financial statements should include the independent certified public accountant's opinion on the statements.

- Evidence that the parent company has majority control of the licensee's voting stock. Such evidence can include incorporation agreements (i.e., copies of submissions to the appropriate State Corporation Commission), Schedule 22 from the parent company's SEC Form 10-K, or a certified corporate resolution that the licensee and the parent company guarantor are separate and distinct corporate entities and that the parent company controls a majority of the voting stock of the subsidiary. If the parent company does not have majority control of the licensee's voting stock, the licensee should provide details on the parent-subsidiary relationship to NRC for review.

- A *standby trust fund*, although not required under NRC regulations, is recommended for use with parent company guarantees. The standby trust fund should be ready to receive funds from the guarantee. The standby trust fund should satisfy the criteria described in Section 17 and in Checklist 17-A of this Appendix.

CHECKLIST 13-B

Terms and Conditions Needed in Parent Company Guarantees

Use this checklist only if deviating from the wording recommended in Section 13.10.

- ☐ Name and address of guarantor.
- ☐ Name and address of licensee.
- ☐ Name and address of regulatory agency.
- ☐ The following five recitals:
  - (1) The authority of the guarantor to enter into the guarantee;
  - (2) The licensee's regulatory obligations as reason for the parent guarantee;
  - (3) The names, addresses, and license numbers of the facilities for which the guarantee provides financial assurance and the amounts guaranteed for decommissioning activities;
  - (4) Financial test I or II used by guarantor to demonstrate financial strength; and
  - (5) The guarantor's authority to provide the guarantee, such as ownership of the licensee as evidenced by majority control of the voting stock of the licensee.
- ☐ Description of the primary obligation (required activities).
- ☐ Unequivocal statement of guarantee:
  - ☐ 1. Recitation of the consideration for the guarantee; and
  - ☐ 2. Liability of the guarantor:
    - ☐ a. Limitation of liability
    - ☐ b. Conditions of liability
    - ☐ c. Effect on liability of a change in the status of the licensee.
- ☐ Statement that guarantor remains bound despite amendment or modification of license, reduction or extension of time of performance of required activities, or any other modification or alteration of an obligation of the licensee.
- ☐ Notice requirements.
- ☐ Discharge of the guarantor (release of obligations).
- ☐ Termination and revocation:
  - ☐ 1. Termination on occurrence of contingency;
  - ☐ 2. Voluntary revocation by guarantor; and
  - ☐ 3. Effective date of termination or revocation.
- ☐ Date.
- ☐ Signatures.
- ☐ Signature of witness or notary (signature block).

13.4 MODEL CHIEF EXECUTIVE OFFICER (CEO) LETTER

[Address to U.S. Nuclear Regulatory Commission]

I am the chief executive officer of [insert name and address of licensee], a [insert "proprietorship," "partnership," or "corporation"]. This letter is in support of this firm's use of the financial test to demonstrate financial assurance, as specified in 10 CFR Part [insert 30, 40, 70, or 72].

I hereby certify that [insert name of licensee] is currently a going concern, and that it possesses positive tangible net worth in the amount of [insert amount].

This firm [insert "is required" or "is not required"] to file a Form 10-K with the U.S. Securities and Exchange Commission for the latest fiscal year. This fiscal year of this firm ends on [insert month and day].

I hereby certify that the content of this letter is true and correct to the best of my knowledge.

[Signature]
[Name]
[Title]
[Date]

13.5 MODEL CHIEF FINANCIAL OFFICER (CFO) LETTER

[Address to U.S. Nuclear Regulatory Commission]

I am the chief financial officer of [insert name and address of parent guarantor], a [insert "proprietorship," "partnership," or "corporation"]. This letter is in support of this firm's use of the financial test to demonstrate financial assurance, as specified in 10 CFR Part [insert 30, 40, 70, or 72].

[Complete the following paragraph regarding facility(ies) and associated cost estimates or certified amounts. For each facility, include its license number, name, address, and current cost estimates or certified amounts for the specified activities.]

This firm guarantees, through the parent company guarantee submitted to demonstrate compliance under 10 CFR Part [insert 30, 40, 70, or 72], the decommissioning of the following facilities owned or operated by subsidiaries of this firm. The current cost estimates or certified amounts for decommissioning, so guaranteed, are shown for each facility:

Name of Facility	License Number	Location of Facility	Certified Amounts or Current Cost Estimates

This firm [insert "is required" or " is not required"] to file a Form 10-K with the U.S. Securities and Exchange Commission for the latest fiscal year.

This fiscal year of this firm ends on [insert month and day]. The figures for the following items marked with an asterisk are derived from this firm's independently audited, year-end financial statements and footnotes for the latest completed fiscal year, ended [insert date]. A copy of this firm's most recent financial statements is enclosed.

[Insert completed Financial Test I or II of the parent company.]

I hereby certify that the content of this letter is true and correct to the best of my knowledge.

[Signature]
[Name]
[Title]
[Date]

13.6 MODEL PARENT COMPANY GUARANTEE FINANCIAL TEST I

1.	Current decommissioning cost estimates or certified amounts		
	a. Decommissioning amounts covered by this parent company guarantee	$______	
	b. All decommissioning amounts covered by other NRC or Agreement State parent company guarantees or self-guarantees	$______	
	c. All amounts covered by parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA)	$______	
	TOTAL		$______
*2.	Total liabilities (if any portion of the cost estimates for decommissioning is included in total liabilities on your firm's financial statements, you may deduct the amount of that portion from this line and add that amount to lines 3 and 4)		$______
*3.	Tangible net worth**		$______
*4.	Net worth		$______
*5.	Current assets		$______
*6.	Current liabilities		$______
*7.	Net working capital (line 5 minus line 6)		$______
*8.	The sum of net income plus depreciation, depletion, and amortization		$______
*9.	Total assets in United States (required only if less than 90 percent of firm's assets are located in the United States)		$______

		Yes	No
10.	Is line 3 at least $10 million?	___	___
11.	Is line 3 at least 6 times line 1?	___	___
12.	Is line 7 at least 6 times line 1?	___	___
13.	Are at least 90 percent of firms's assets located in the United States? If not, complete line 14.	___	___
14.	Is line 9 at least 6 times line 1?	___	___

Guarantor must meet two of the following three ratios:

15.	Is line 2 divided by line 4 less than 2.0?	___	___
16.	Is line 8 divided by line 2 greater than 0.1?	___	___
17.	Is line 5 divided by line 6 greater than 1.5?	___	___

* Denotes figures derived from financial statements.
** Tangible net worth is defined as net worth minus goodwill, patents, trademarks, and copyrights.

13.7 MODEL PARENT COMPANY GUARANTEE FINANCIAL TEST II

1. Current decommissioning cost estimates or certified amounts
   a. Decommissioning amounts covered by this parent company guarantee $______
   b. All decommissioning amounts covered by other NRC or Agreement State parent company guarantees or self-guarantees $______
   c. All amounts covered by parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA) $______

   TOTAL $______

2. Current bond rating of most recent unsecured issuance of this firm
   Rating ________
   Name of rating service ______________________

3. Date of issuance of bond ______

4. Date of maturity of bond ______

*5. Tangible net worth** (if any portion of estimates for decommissioning is included in total liabilities on your firm's financial statements, you may add the amount of that portion to this line) $______

*6. Total assets in United States (required only if less than 90 percent of firm's assets are located in the United States) $______

		Yes	No
7.	Is line 5 at least $10 million?	___	___
8.	Is line 5 at least 6 times line 1?	___	___
9.	Are at least 90 percent of firm's assets located in the United States? If not, complete line 10.	___	___
10.	Is line 6 at least 6 times line 1?	___	___
11.	Is the rating specified on line 2 "BBB" or better (if issued by Standard & Poor's) or "Baa" or better (if issued by Moody's)?	___	___

____

* Denotes figures derived from financial statements.
** Tangible net worth is defined as net worth minus goodwill, patents, trademarks, and copyrights.

13.8 MODEL AUDITOR'S SPECIAL REPORT

CONFIRMATION OF CHIEF FINANCIAL OFFICER'S LETTER

We have examined the financial statements of [insert name of parent guarantor] for the year ended [insert date], and have issued our report thereon dated [insert date]. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary.

[Insert name of parent guarantor] has prepared documents to demonstrate its financial responsibility under the NRC's financial assurance regulations, 10 CFR Part [insert 30, 40, 70, or 72]. This letter is furnished to assist the licensee [insert name and NRC license number] in complying with these regulations and should not be used for other purposes.

The attached schedule reconciles the specified information furnished in the chief financial officer's (CFO's) letter in response to the regulations with the company's financial statements. In connection therewith, we have

1. Confirmed that the amounts in the column "Per Financial Statements" agree with amounts contained in the company's financial statements for the year ended [insert date];

2. Confirmed that the amounts in the column "Per CFO's Letter" agree with the letter prepared in response to the NRC's request;

3. Confirmed that the amounts, if any, in the column "Reconciling Items" are adequately explained in the attached schedule, that each reconciling item represents an appropriate adjustment to the financial data, and that the amount of each reconciling item is accurate; and

4. Recomputed the totals and percentages.

Because the procedures in 1-4 above do not constitute a full examination made in accordance with generally accepted auditing standards, we do not express an opinion on the manner in which the amounts were derived in the items referred to above. In connection with the procedures referred to above, no matters came to our attention that cause us to believe that the chief financial officer's letter and supporting information should be adjusted.

____
Signature

____
Date

13.9 MODEL SCHEDULE RECONCILING AMOUNTS CONTAINED IN CHIEF FINANCIAL OFFICER'S LETTER WITH AMOUNTS IN FINANCIAL STATEMENTS

XYZ COMPANY

YEAR ENDED DECEMBER 31, 19XX

Line Number in CFO's Letter		Per Financial Statements	Reconciling Items	Per CFO's Letter
6	Total current liabilities	X		
	Long-term debt	X		
	Deferred income taxes	X		
		XXX		
	Accrued decommissioning costs included in current liabilities		X	
	Total liabilities (less accrued decommissioning costs)			X
4	Net worth	XX		
	Less: Cost in excess of value of tangible assets acquired	X		
		X		
	Accrued decommissioning costs included in current liabilities		X	
	Tangible net worth (plus decommissioning costs)			XX

(Balance of schedule is not illustrated.)
This illustrates the form of schedule that is contemplated. Details and reconciling items will differ in specific situations.

13.10 MODEL PARENT COMPANY GUARANTEE AGREEMENT

PARENT COMPANY GUARANTEE

Guarantee made this [insert date] by [insert name of guaranteeing entity], a [insert "proprietorship," "partnership," or "corporation"] organized under the laws of the State of [insert name of State], herein referred to as "guarantor," to the U.S. Nuclear Regulatory Commission (NRC), beneficiary, on behalf of our subsidiary [insert name of licensee], of [insert business address].

<u>Recitals</u>

1. The guarantor has full authority and capacity to enter into this guarantee [if the guarantor is a corporation, insert the following: "under its bylaws, articles of incorporation, and the laws of the State of [insert guarantor's State of incorporation], its State of incorporation."] [If the guarantor has a Board of Directors, insert the following: "Guarantor has approval from its Board of Directors to enter into this guarantee."]

2. This guarantee is being issued to comply with regulations issued by the NRC, an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. NRC has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72] which require that a holder of, or an applicant for, a materials license issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72] provide assurance that funds will be available when needed for required decommissioning activities.

3. The guarantee is issued to provide financial assurance for decommissioning activities for [identify name and address of licensed facility(ies) and corresponding NRC license number(s)] as required by 10 CFR Part [insert 30, 40, 70, or 72]. The decommissioning costs for these activities are as follows: [insert amount of decommissioning costs guaranteed for each identified facility].

4. The guarantor meets or exceeds the following financial test criteria [insert statement indicating which financial test is being used] and agrees to comply with all notification requirements as specified in 10 CFR Part [insert 30, 40, 70, or 72] and Appendix A to 10 CFR Part 30.

   The guarantor meets one of the following two financial tests:

   (a)(i) Two of the following three ratios: a ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5; and

   (a)(ii) Net working capital and tangible net worth each at least six times the costs covered by financial tests; and (a)(iii) Tangible net worth of at least $10 million; and

(a)(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the costs covered by financial tests.

OR

(b)(i) A current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard & Poor's, or Aaa, Aa, A or Baa as issued by Moody's; and

(b)(ii) Tangible net worth at least six times the costs covered by financial tests; and

(b)(iii) Tangible net worth of at least $10 million; and

(b)(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the costs covered by financial tests.

5. The guarantor has majority control of the voting stock for the following licensees covered by this guarantee: [List for each licensee: name, address, the facilities owned or operated by each licensee, and the corresponding license numbers.]

6. Decommissioning activities as used below refer to the activities required by 10 CFR Part [insert 30, 40, 70, or 72] for decommissioning of the facilities identified above.

7. For value received from [insert name of licensee], and pursuant to the guarantor's authority to enter into this guarantee, the guarantor guarantees to the NRC that if the licensee fails to perform the required decommissioning activities, as required by License No. [insert license number], the guarantor shall

(a) carry out the required activities, <u>or</u>

(b) set up a trust fund in favor of the above identified beneficiary in the amount of the current cost estimates for these activities.

8. The guarantor agrees to submit revised financial statements, financial test data, and an auditor's special report and reconciling schedule annually within 90 days of the close of the parent guarantor's fiscal year.

9. The guarantor agrees that if, at the end of any fiscal year before termination of this guarantee, it fails to meet the financial test criteria, the licensee shall send within 90 days of the end of the fiscal year, by certified mail, notice to the NRC that the licensee intends to provide alternative financial assurance as specified in 10 CFR Part [insert 30, 40, 70, or 72]. Within 120 days after the end of the fiscal year, the guarantor shall establish such financial assurance if the [insert name of licensee] has not done so.

10. The guarantor also agrees to notify the beneficiary promptly if the ownership of the licensee or the parent firm is transferred and to maintain this guarantee until the new

parent firm or the licensee provides alternative financial assurance acceptable to the beneficiary.

11. The guarantor agrees that if it determines, at any time other than as described in Recital 9, that it no longer meets the financial test criteria or it is disallowed from continuing as a guarantor, it shall establish alternative financial assurance as specified in 10 CFR Part 30, 40, 70, or 72, as applicable, within 30 days, in the name of [insert name of licensee] unless [insert name of licensee] has done so.

12. The guarantor as well as its successors and assigns agree to remain bound jointly and severally under this guarantee notwithstanding any or all of the following: amendment or modification of license or NRC-approved decommissioning funding plan for that facility, the extension or reduction of the time of performance of required activities, or any other modification or alteration of an obligation of the licensee pursuant to 10 CFR Part [insert 30, 40, 70, or 72].

13. The guarantor agrees that all bound parties shall be jointly and severally liable for all litigation costs incurred by the beneficiary, NRC, in any successful effort to enforce the agreement against the guarantor.

14. The guarantor agrees to remain bound under this guarantee for as long as [insert name of licensee] must comply with the applicable financial assurance requirements of 10 CFR Part [insert 30, 40, 70, or 72], for the previously listed facilities, except that the guarantor may cancel this guarantee by sending notice by certified mail to the NRC and to [insert name of licensee], such cancellation to become effective no earlier than 120 days after receipt of such notice by both the NRC and [insert name of licensee] as evidenced by the return receipts.

15. The guarantor agrees that if [insert name of licensee] fails to provide alternative financial assurance as specified in 10 CFR Part [insert 30, 40, 70, or 72], as applicable, and obtain written approval of such assurance from the NRC within 90 days after a notice of cancellation by the guarantor is received by both the NRC and [insert name of licensee] from the guarantor, the guarantor shall provide such alternative financial assurance in the name of [insert name of licensee] or make full payment under the guarantee.

16. The guarantor expressly waives notice of acceptance of this guarantee by the NRC or by [insert name of licensee]. The guarantor also expressly waives notice of amendments or modifications of the decommissioning requirements and of amendments or modifications of the license.

17. If the guarantor files financial reports with the U.S. Securities and Exchange Commission, then it shall promptly submit them to the NRC during each year in which this guarantee is in effect.

I hereby certify that this guarantee is true and correct to the best of my knowledge.

Effective date: ___________________

[Name of guarantor]

[Authorized signature for guarantor]

[Name of person signing]

[Title of person signing]

Signature of witness or notary: _____________________

14. SELF-GUARANTEES

A *self-guarantee* is a guarantee by a licensee itself that it will fund and carry out decommissioning activities. The licensee must annually pass (within 90 days after the close of each succeeding fiscal year) the applicable financial test specified in Appendix C, D, or E to 10 CFR Part 30 to demonstrate that it has adequate financial strength to provide the guarantee.[28] The financial test alternatives consider accounting ratios, net worth, assets, operating revenues, and bond rating data relative to fixed criteria. Also, the licensee's financial statements must have been prepared in accordance with generally accepted accounting principles applicable to the United States, and an independent certified public accountant must have verified the accuracy of the financial test data relative to the audited financial statements. A self-guarantee may not be used in combination with other financial assurance mechanisms, and may not be used in cases where a licensee has a parent company holding majority control of its voting stock.

NRC's regulations for self-guarantees apply to three general categories of licensees:

- *Commercial companies that issue bonds*. Self-guarantees by these licensees are regulated under Appendix C to 10 CFR Part 30.

- *Commercial companies that do not issue bonds*. Self-guarantees by these licensees are regulated under Appendix D to 10 CFR Part 30.

- *Non-profit colleges, universities, and hospitals*. Self-guarantees by these licensees are regulated under Appendix E to 10 CFR Part 30.

A self-guarantee must remain in force unless the licensee sends notice of cancellation by certified mail to NRC. For a commercial licensee that issues bonds, this notice must be sent at least 120 days in advance (as evidenced by the return receipts). For a commercial licensee that does not issue bonds or a non-profit college, university, or hospital, the guarantee may not be canceled until an alternative financial assurance mechanism is in place. However, in all cases, a self-guarantee may be used only as long as the licensee meets the financial test criteria. If the licensee no longer passes the financial test, it must provide alternative financial assurance.

Finally, the licensee must provide a written guarantee stating that it will fund and carry out the required decommissioning activities or, upon issuance of an order by NRC, will set up and fund a trust in the amount of the current decommissioning cost estimates or certified amounts.

The remainder of this section discusses the primary criteria that determine whether particular self-guarantee submissions will be acceptable to NRC.

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[28] The financial tests specified in Appendices C, D, and E to 10 CFR Part 30 also apply to licensees regulated under 10 CFR Parts 40, 70, and 72.

CHECKLIST 14-A

SELF-GUARANTEES

- ☐ Documentation is complete:
  - ☐ 1. Self-guarantee agreement (originally signed duplicate)
  - ☐ 2. Letter from chief executive officer or chief financial officer of licensee, including applicable self-guarantee financial test
  - ☐ 3. Auditor's special report confirming CEO or CFO letter and reconciling amounts in the CEO or CFO letter with licensee's financial statements
  - ☐ 4. Licensee's audited financial statements for the most recent fiscal year, including the auditor's opinion on the financial statements
  - ☐ 5. Checklist 14-B (if model self-guarantee wording is modified or not used)
- ☐ The licensee does not have a parent company holding majority control of its voting stock.
- ☐ The amount of the self-guarantee equals or exceeds the required coverage level.

- Section 14.1 describes qualifications required of the self-guarantor.
- Section 14.2 addresses the adequacy of coverage.
- Section 14.3 discusses the documentation that supports a self-guarantee.
- Section 14.4 presents a model self-guarantee that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees in preparing acceptable self-guarantees. Checklist 14-A summarizes the primary criteria used by NRC to evaluate self-guarantees. Checklist 14-B (which should be used only by licensees that revise or do not use the model wording for self-guarantees) presents terms and conditions that are recommended for self-guarantees.

14.1 QUALIFICATIONS OF THE SELF-GUARANTOR

As noted above, a licensee using a self-guarantee to provide financial assurance for decommissioning must *not* have a parent company holding majority control of its voting stock.[29] To qualify to provide the guarantee, the licensee also must meet the applicable financial test specified in Appendix C, D or E to 10 CFR Part 30 (shown in the boxes below).

[29] See 10 CFR 30.35(f)(2), 40.36(e)(2), 70.25(f)(2), and 72.30(c)(2).

- The financial test specified in Appendix C pertains to commercial companies that issue bonds.

- The financial test specified in Appendix D pertains to commercial companies that do not issue bonds.

- The financial tests specified in Appendix E pertain to non-profit colleges, universities, and hospitals.

Licensees without an actual bond rating may still use the financial tests involving bond ratings by obtaining a so-called “indicative” bond rating from either Standard & Poor’s or Moody’s. Indicative bond ratings, which are available for a fee, are for information only and are provided as an indication of what a rating would be if the firm were to issue debt. A licensee seeking to use an indicative bond rating should submit the rating and name of the rating service as part of the financial test demonstration. In this case, however, the licensee would not be able to provide NRC with information on the dates of issuance and maturity of the bond, nor would it be able to certify that the rating pertained to its “most recent bond issuance.” Rather, the licensee would need to explain that the rating is an indicative rating. The licensee would also need to update the indicative rating every year as it repeats the passage of the financial test.

For purposes of the financial tests, bond ratings must apply to outstanding, rated bonds that are not secured by insurance, a letter of credit, or other collateral or guarantee, and that have been issued by the licensee *directly*, rather than by any other entity (e.g., an educational authority). In addition, ratings on revenue bonds may not be used in the financial test. The scope of revenue bond ratings is typically quite limited in that the rating considers only the adequacy of specific revenue sources pledged to repay the bonds. Revenue bonds frequently require that the pledged revenue be used to repay the bonded debt before paying other operating expenses and, therefore, do not meet NRC’s regulatory requirement that the bonds be “uninsured, uncollateralized, and unencumbered.” If the revenue sources are clearly adequate to repay the bonds, the revenue bond rating may be high, even if the issuer’s revenue is clearly not adequate to pay other operating expenses. Thus, unlike bonds that pledge an entity’s full faith and credit, ratings on revenue bonds do not reflect the overall financial condition of the issuer, as intended by NRC’s self-guarantee regulations.

Financial Test for Commercial Companies that Issue Bonds

The licensee must have:

(i) Tangible net worth at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor;
(ii) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and
(iii) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

(**Note**: Ratings of A- by S&P and A3 by Moody's are not sufficient to pass the self-guarantee financial test because they are below the A rating required under 10 CFR Part 30, Appendix C.)

(**Note**: In order to pass the financial test, a commercial licensee that issues bonds also must have at least one class of equity securities registered under the Securities Exchange Act of 1934.)

Financial Test for Commercial Companies that Do Not Issue Bonds

The licensee must have:

(i) Tangible net worth greater than $10 million, or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used), whichever is greater, for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor;
(ii) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and
(iii) A ratio of cash flow divided by total liabilities greater than 0.15 and a ratio of total liabilities divided by net worth less than 1.5.

(**Note**: Cash flow equals the sum of net income plus depreciation, depletion, and amortization.)

Financial Test for Non-Profit Colleges and Universities that Issue Bonds

The licensee must have a current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

(**Note**: An "uninsured, uncollateralized, and unencumbered" bond issuance is one that is backed only by the issuer's full faith and credit. Such issuances are not guaranteed by a bond insurance company or backed by collateral, a letter of credit, claims on a specific revenue source, or any other property or credit.)

(**Note**: Ratings of A- by S&P and A3 by Moody's are not sufficient to pass the self-guarantee financial test because they are below the A rating required under 10 CFR Part 30, Appendix E.)

Financial Test for Non-Profit Colleges and Universities that Do Not Issue Bonds

The licensee must have unrestricted endowment consisting of assets located in the United States of at least $50 million, or at least 30 times the current decommissioning cost estimates (or prescribed amount if a certification is used), whichever is greater, for all decommissioning activities for which the college or university is responsible as a self-guaranteeing licensee.

Financial Test for Non-Profit Hospitals that Issue Bonds

The licensee must have a current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

(**Note:** An "uninsured, uncollateralized, and unencumbered" bond issuance is one that is backed only by the issuer's full faith and credit. Such issuances are not guaranteed by a bond insurance company or backed by collateral, a letter of credit, claims on a specific revenue source, or any other property or credit.)

(**Note**: Ratings of A- by S&P and A3 by Moody's are not sufficient to pass the self-guarantee financial test because they are below the A rating required under 10 CFR Part 30, Appendix E.)

Financial Test for Non-Profit Hospitals that Do Not Issue Bonds

The licensee must have:

(i) (Total revenues less total expenditures) divided by total revenues must be equal to or greater than 0.04; and
(ii) Long-term debt divided by net fixed assets must be less than or equal to 0.67; and
(iii) (Current assets and depreciation fund) divided by current liabilities must be greater than or equal to 2.55; and
(iv) Operating revenues must be at least 100 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the hospital is responsible as a self-guaranteeing licensee.

14.2 LEVEL OF COVERAGE

A self-guarantee must be in an amount that is at least equal to the licensee's certification amount or estimated cost of decommissioning. If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the self-guarantee, the licensee must revise the guarantee to assure the higher amount (or must replace the guarantee with a different financial assurance mechanism that is in the amount of the new coverage level).[30]

14.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a self-guarantee are governed by a written guarantee agreement. The wording of a self-guarantee agreement may vary, but Section 14.13 of this Appendix is a model self-guarantee agreement that would meet NRC's requirements and is recommended by NRC. Other documentation that is to be submitted with a self-guarantee includes the following and is summarized in Checklist 14-A[31]

- The *guarantee agreement* is the written document that specifies the terms and conditions of the self-guarantee. The wording contained in the model guarantee presented in Section 14.13 is acceptable to NRC. Licensees who use other wording should refer to Checklist 14-B to be sure that the alternative wording contains all the necessary terms and conditions.

- The *chief executive officer (CEO) or chief financial officer (CFO) letter* (Section 14.4) is a letter from either the CEO or CFO of the licensee that (1) identifies the names, addresses, license numbers, and estimated decommissioning costs of the facilities covered by the guarantee, (2) certifies that the licensee is a going concern, (3) identifies the amount of the licensee's tangible net worth, (4) specifies whether the licensee is required to file a Form 10-K with the U.S. Securities and Exchange Commission, (5) lists the date on which the licensee's fiscal year ends, and (6) demonstrates the licensee's ability to pass the applicable financial test specified in Appendix C, D, or E to 10 CFR Part 30. The licensee must pass the financial test for <u>all</u> costs covered by a financial test. These include costs covered by (1) the self-guarantee, (2) other NRC or Agreement State parent company guarantees or self-guarantees, and (3) parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA).

- The *auditor's special report* (Section 14.11) is a report from the licensee's independent certified public accountant that compares the data used by the licensee in the financial test demonstration with the amounts in its annual financial statements. If needed, this

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[30] Because a self-guarantee may not be used in combination with any other financial assurance mechanism, licensees do not have the option of obtaining another mechanism to make up differences between increased coverage levels and guaranteed amounts.

[31] Supporting documentation may differ for licensees who submit self-guarantees that differ from the recommended model.

report may also include a *schedule attachment* (Section 14.12) reconciling the financial test numbers with amounts in the licensee's financial statements.

- A copy of the licensee's *audited financial statements* for the most recently completed fiscal year. These financial statements should include the independent certified public accountant's opinion on the statements.

CHECKLIST 14-B

Terms and Conditions Needed in Self-Guarantees

Use this checklist only if deviating from the wording recommended in Section 14.13.

□ Name and address of self-guarantor (licensee).
□ Name and address of regulatory agency.
□ The following four recitals:
  (1) The authority of the self-guarantor to enter into the guarantee;
  (2) A statement of the licensee's regulatory obligations as reason for the self-guarantee;
  (3) Identification of the facility(ies) (name, address, and license number) for which the guarantee provides financial assurance and the amounts guaranteed for decommissioning activities; and
  (4) Identification of financial test used by self-guarantor to demonstrate financial strength.
□ Description of the primary obligation (required activities).
□ Unequivocal statement of guarantee:
  □ 1. Condition(s) of liability; and
  □ 2. Effect on liability of a change in the status of the licensee.
□ Statement that self-guarantor remains bound despite amendment or modification of license, reduction or extension of time of performance of required activities, or any other modification or alteration of an obligation of the licensee.
□ Notice requirements.
□ Discharge of the self-guarantor (release of obligations).
□ Termination and revocation:
  □ 1. Termination on occurrence of contingency;
  □ 2. Voluntary revocation by self-guarantor; and
  □ 3. Effective date of termination or revocation.
□ Date.
□ Signatures.
□ Signature of witness or notary (signature block).

14.4 MODEL CHIEF EXECUTIVE OFFICER (CEO) OR CHIEF FINANCIAL OFFICER (CFO) LETTER

[Address to U.S. Nuclear Regulatory Commission]

I am the [insert "chief executive officer" or "chief financial officer"] of [insert name and address of licensee], a [insert "proprietorship," "partnership," "corporation," "non-profit college," "non-profit university," or "non-profit hospital"]. This letter is in support of this firm's use of the self-guarantee financial test to demonstrate financial assurance, as specified in 10 CFR Part [insert 30, 40, 70, or 72]. This firm has no parent company holding majority control of its voting stock.

[Complete the following paragraph regarding facilities and associated cost estimates or certified amounts. For each facility, include its license number, name, address, and current cost estimates or certified amounts for the specified activities.]

This firm guarantees, through the self-guarantee submitted to demonstrate compliance under 10 CFR Part [insert 30, 40, 70, or 72], the decommissioning of the following facilities owned or operated by this firm. The current cost estimates or certified amounts for decommissioning, so guaranteed, are shown for each facility:

Name of Facility	License Number	Location of Facility	Certified Amounts or Current Cost Estimates

I hereby certify that [insert name of licensee] is currently a going concern, and that it possesses positive tangible net worth in the amount of [insert amount].

This fiscal year of this firm ends on [insert month and day]. The figures for the following items marked with an asterisk are derived from this firm's independently audited, year-end financial statements and footnotes for the latest completed fiscal year, ended [insert date]. A copy of this firm's most recent financial statements is enclosed.

This firm [insert "is required" or " is not required"] to file a Form 10-K with the U.S. Securities and Exchange Commission for the latest fiscal year. [If the licensee is a commercial company that issues bonds, insert the following: "This firm has at least one class of equity securities registered under the Securities Exchange Act of 1934."]

This firm satisfies the following self-guarantee test:

[Insert completed demonstration of the applicable self-guarantee financial test.]

I hereby certify that the content of this letter is true and correct to the best of my knowledge.

[Signature]
[Name]
[Title]
[Date]

14.5 MODEL SELF-GUARANTEE FINANCIAL TEST FOR COMMERCIAL COMPANIES THAT ISSUE BONDS (10 CFR Part 30, Appendix C)

1. Current decommissioning cost estimates or certified amounts
   a. Decommissioning amounts covered by this self-guarantee $______
   b. All decommissioning amounts covered by other NRC or Agreement State parent company guarantees or self-guarantees $______
   c. All amounts covered by parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA) $______

   TOTAL $______

2. Current bond rating of most recent unsecured issuance of this firm
   Rating ________
   Name of rating service ______________________

3. Date of issuance of bond ______

4. Date of maturity of bond ______

*5. Tangible net worth** (if any portion of estimates for decommissioning is included in total liabilities on your firm's financial statements, you may add the amount of that portion to this line) $______

*6. Total assets in United States (required only if less than 90 percent of firm's assets are located in the United States) $______

		Yes	No
7.	Is line 5 at least 10 times line 1?	___	___
8.	Are at least 90 percent of firm's assets located in the United States? If not, complete line 9.	___	___
9.	Is line 6 at least 10 times line 1?	___	___
10.	Is the rating specified on line 2 "A" or better?	___	___
11.	Does the licensee have at least one class of equity securities registered under the Securities Exchange Act of 1934?	___	___

* Denotes figures derived from financial statements.
** Tangible net worth is defined as net worth minus goodwill, patents, trademarks, and copyrights.

14.6 MODEL SELF-GUARANTEE FINANCIAL TEST FOR COMMERCIAL COMPANIES THAT DO NOT ISSUE BONDS (10 CFR Part 30, Appendix D)

1.	Current decommissioning cost estimates or certified amounts		
	a. Decommissioning amounts covered by this self-guarantee	$______	
	b. All decommissioning amounts covered by other NRC or Agreement State parent company guarantees or self-guarantees	$______	
	c. All amounts covered by parent company guarantees, self-guarantees, or financial tests of other Federal or State agencies (e.g., EPA)	$______	
	TOTAL		$______
*2.	Total liabilities (if any portion of the cost estimates for decommissioning is included in total liabilities on your firm's financial statements, you may deduct the amount of that portion from this line and add that amount to lines 3 and 4)		$______
*3.	Tangible net worth**		$______
*4.	Net worth		$______
*5.	The sum of net income plus depreciation, depletion, and amortization		$______
*6.	Total assets in United States (required only if less than 90 percent of firm's assets are located in the United States)		$______

		Yes	No	
7.	Is line 3 greater than $10 million, or at least 10 times line 1, whichever is greater?	___	___	
8.	Are at least 90 percent of the firms's assets located in the United States? If not, complete line 9.	___	___	
9.	Is line 6 at least 10 times line 1?	___	___	
10.	Is line 5 divided by line 2 greater than 0.15?		___	___
11.	Is line 2 divided by line 4 less than 1.5?	___	___	

* Denotes figures derived from financial statements.
** Tangible net worth is defined as net worth minus goodwill, patents, trademarks, and copyrights.

14.7 MODEL SELF-GUARANTEE FINANCIAL TEST FOR NON-PROFIT COLLEGES AND UNIVERSITIES THAT ISSUE BONDS (10 CFR Part 30, Appendix E)

1. Current bond rating of most recent uninsured, uncollateralized, and unencumbered issuance of this institution

   Rating ________
   Name of rating service ________________________

2. Date of issuance of bond _______

3. Date of maturity of bond _______

		Yes	No
4.	Is the rating specified on line 1 "A" or better?	___	___

14.8 MODEL SELF-GUARANTEE FINANCIAL TEST FOR NON-PROFIT COLLEGES AND UNIVERSITIES THAT DO NOT ISSUE BONDS (10 CFR Part 30, Appendix E)

1. Current decommissioning cost estimates or certified amounts
   a. Decommissioning amounts covered by this self-guarantee $______
   b. All decommissioning amounts covered by other NRC or Agreement State self-guarantees $______
   c. All amounts covered by self-guarantees or financial tests of other Federal or State agencies (e.g., EPA) $______

   TOTAL $______

*2. Total assets in United States in unrestricted endowment $______

	Yes	No
3. Is line 2 at least $50 million, or at least 30 times line 1, whichever is greater?	___	___

* Denotes figures derived from financial statements.

14.9 MODEL SELF-GUARANTEE FINANCIAL TEST FOR NON-PROFIT HOSPITALS THAT ISSUE BONDS (10 CFR Part 30, Appendix E)

1. Current bond rating of most recent uninsured, uncollateralized, and unencumbered issuance of this institution

   Rating ________
   Name of rating service ________________________

2. Date of issuance of bond _______

3. Date of maturity of bond _______

	Yes	No
4. Is the rating specified on line 1 "A" or better?	___	___

14.10 MODEL SELF-GUARANTEE FINANCIAL TEST FOR NON-PROFIT HOSPITALS THAT DO NOT ISSUE BONDS (10 CFR Part 30, Appendix E)

1.	Current decommissioning cost estimates or certified amounts				
	a. Decommissioning amounts covered by this self-guarantee	$______			
	b. All decommissioning amounts covered by other NRC or Agreement State self-guarantees	$______			
	c. All amounts covered by self-guarantees or financial tests of other Federal or State agencies (e.g., EPA)		$______		
	TOTAL			$______	
*2.	Total revenues			$______	
*3.	Operating revenues				
*4.	Total expenditures			$______	
*5.	Long-term debt			$______	
*6.	Net fixed assets			$______	
*7.	Current assets			$______	
*8.	Depreciation fund			$______	
*9.	Current liabilities			$______	
		Yes	No		
10.	Is line 3 at least 100 times line 1?	___	___		

Guarantor must meet each of the following ratios:

11.	Is (line 2 minus line 4) divided by line 2 at least 0.04?	___	___	
12.	Is line 5 divided by line 6 less than or equal to 0.67?	___	___	
13.	Is (line 7 plus line 8) divided by line 9 at least 2.55?		___	___

* Denotes figures derived from financial statements.

14.11 MODEL AUDITOR'S SPECIAL REPORT

CONFIRMATION OF LETTER FROM [Insert "CHIEF EXECUTIVE OFFICER" or "CHIEF FINANCIAL OFFICER"]

We have examined the financial statements of [insert name of self-guarantor] for the year ended [insert date], and have issued our report thereon dated [insert date]. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary.

[Insert name of self-guarantor] has prepared documents to demonstrate its financial responsibility under the NRC's financial assurance regulations, 10 CFR Part [insert 30, 40, 70, or 72]. This letter is furnished to assist the licensee [insert name and NRC license number] in complying with these regulations and should not be used for other purposes.

The attached schedule reconciles the specified information furnished in the [insert "chief executive officer's (CEO's)" or "chief financial officer's (CFO's)"] letter in response to the regulations with the [insert "company's" or "institution's"] financial statements. In connection therewith, we have

1. Confirmed that the amounts in the column "Per Financial Statements" agree with amounts contained in the [insert "company's" or "institution's"] financial statements for the year ended [insert date];

2. Confirmed that the amounts in the column "Per [insert "CEO's" or "CFO's"] Letter" agree with the letter prepared in response to the NRC's request;

3. Confirmed that the amounts, if any, in the column "Reconciling Items" are adequately explained in the attached schedule, that each reconciling item represents an appropriate adjustment to the financial data, and that the amount of each reconciling item is accurate; and

4. Recomputed the totals and percentages.

Because the procedures in 1-4 above do not constitute a full examination made in accordance with generally accepted auditing standards, we do not express an opinion on the manner in which the amounts were derived in the items referred to above. In connection with the procedures referred to above, no matters came to our attention that cause us to believe that the [insert "chief executive officer's" or "chief financial officer's"] letter and supporting information should be adjusted.

____
Signature

____
Date

14.12 MODEL SCHEDULE RECONCILING AMOUNTS CONTAINED IN CHIEF EXECUTIVE OFFICER'S OR CHIEF FINANCIAL OFFICER'S LETTER WITH AMOUNTS IN FINANCIAL STATEMENTS

XYZ COMPANY

YEAR ENDED DECEMBER 31, 19XX

Line Number in CEO's or CFO's Letter		Per Financial Statements	Recon-ciling Items	Per CEO's or CFO's Letter
	Net worth	XX		
	Less: Cost in excess of value of tangible assets acquired	X		
		X		
	Accrued decommissioning costs included in current liabilities		X	
5	Tangible net worth (plus decommissioning costs)			X

(Balance of schedule is not illustrated.)
This illustrates the form of schedule that is contemplated. Details and reconciling items will differ in specific situations.

14.13 MODEL SELF-GUARANTEE AGREEMENT

SELF-GUARANTEE

Guarantee made this [insert date] by [insert name of self-guaranteeing entity], a [insert "proprietorship," "partnership," "corporation," "non-profit college," "non-profit university," or "non-profit hospital"] organized under the laws of the State of [insert name of State], herein referred to as "guarantor," to the U.S. Nuclear Regulatory Commission (NRC), beneficiary, on behalf of ourselves as licensee.

Recitals

1. The guarantor has full authority and capacity to enter into this self-guarantee [if the guarantor is a corporation, insert the following: "under its bylaws, articles of incorporation, and the laws of the State of [insert guarantor's State of incorporation], its State of incorporation."] [If the guarantor has a Board of Directors, insert the following: "Guarantor has approval from its Board of Directors to enter into this self-guarantee."]

2. This self-guarantee is being issued to comply with regulations issued by the NRC, an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. NRC has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72], which require that a holder of, or an applicant for, a materials license issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72] provide assurance that funds will be available when needed for required decommissioning activities.

3. The self-guarantee is issued to provide financial assurance for decommissioning activities for [identify name and address of licensed facilities and corresponding NRC license numbers] as required by 10 CFR Part [insert 30, 40, 70, or 72]. The decommissioning costs for these activities are as follows: [insert amount of decommissioning costs guaranteed for each identified facility].

4. The guarantor meets or exceeds the following financial test criteria [insert statement indicating which financial test is being used] and agrees to comply with all notification requirements as specified in 10 CFR Part [insert 30, 40, 70, or 72] and Appendix [insert C, D, or E] to 10 CFR Part 30.

The guarantor meets the following self-guarantee test:

[If the guarantor is a commercial company that issues bonds, insert the following test]

(a) Tangible net worth at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and

(b) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and

(c) At least one class of equity securities registered under the Securities Exchange Act of 1934; and

(d) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

[If the guarantor is a commercial company that does not issue bonds, insert the following test]

(a) Tangible net worth greater than $10 million, or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used), whichever is greater, for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and

(b) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and

(c) A ratio of cash flow divided by total liabilities greater than 0.15 and a ratio of total liabilities divided by net worth less than 1.5.

[If the guarantor is a non-profit college or university that issues bonds, insert the following test]

(a) A current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

[If the guarantor is a non-profit college or university that does not issue bonds, insert the following test]

(a) Unrestricted endowment consisting of assets located in the United States of at least $50 million, or at least 30 times the current decommissioning cost estimates (or prescribed amount if a certification is used), whichever is greater, for all decommissioning activities for which the college or university is responsible as a self-guaranteeing licensee.

If the guarantor is a non-profit hospital that issues bonds, insert the following test]

(a) A current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

[If the guarantor is a non-profit hospital that does not issue bonds, insert the following test]

(a) (Total revenues less total expenditures) divided by total revenues must be equal to or greater than 0.04; and

(b) Long-term debt divided by net fixed assets must be less than or equal to 0.67; and

(c) (Current assets and depreciation fund) divided by current liabilities must be greater than or equal to 2.55; and

(d) Operating revenues must be at least 100 times the current decommissioning cost estimates (or prescribed amount if a certification is used) for all decommissioning activities for which the hospital is responsible as a self-guaranteeing licensee.

5. The guarantor does not have a parent company holding majority control of its voting stock.

6. Decommissioning activities as used below refer to the activities required by 10 CFR Part [insert 30, 40, 70, or 72] for decommissioning of the facilities identified above.

7. Pursuant to the guarantor's authority to enter into this guarantee, the guarantor guarantees to the NRC that the guarantor shall

(a) carry out the required decommissioning activities, as required by License No. [insert license number] <u>or</u>

(b) set up a trust fund in favor of the above identified beneficiary in the amount of the current cost estimates for these activities.

8. The guarantor agrees to submit revised financial statements, financial test data, and an auditor's special report and reconciling schedule annually within 90 days of the close of its fiscal year.

9. [If the guarantor is a commercial company that issues bonds, insert the following language]

The guarantor agrees that if, at the end of any fiscal year before termination of this self-guarantee, it fails to meet the self-guarantee financial test criteria, it shall send, by certified mail, immediate notice to the NRC that it intends to provide alternative financial assurance as specified in 10 CFR Part [insert 30, 40, 70, or 72]. Within 120 days of such notice, the guarantor shall establish such financial assurance.

[If the guarantor is a commercial company that does not issue bonds or is a non-profit college, university, or hospital, insert the following language]

The guarantor agrees that if, at the end of any fiscal year before termination of this self-guarantee, it fails to meet the self-guarantee financial test criteria, it shall send within 90 days of the end of the fiscal year, by certified mail, notice to the NRC that it intends to provide alternative financial assurance as specified in 10 CFR Part [insert 30, 40, 70, or 72]. Within 120 days after the end of the fiscal year, the guarantor shall establish such financial assurance.

10. The guarantor also agrees to notify the beneficiary promptly if the ownership of the licensed activity is transferred, and to maintain this guarantee until the new licensee provides alternative financial assurance acceptable to the beneficiary.

11. The guarantor agrees that if it determines, at any time other than as described in Recital 9, that it no longer meets the self-guarantee financial test criteria or it is disallowed from continuing as a self-guarantor, it shall establish alternative financial assurance as specified in 10 CFR Part 30, 40, 70, or 72, as applicable, within 30 days.

12. The guarantor, as well as its successors and assigns, agrees to remain bound jointly and severally under this guarantee notwithstanding any or all of the following: amendment or modification of the license or NRC-approved decommissioning funding plan for that facility, the extension or reduction of the time of performance of required activities, or any other modification or alteration of an obligation of the licensee pursuant to 10 CFR Part [insert 30, 40, 70, or 72].

13. The guarantor agrees that it shall be liable for all litigation costs incurred by the beneficiary, NRC, in any successful effort to enforce the agreement against the guarantor.

14. The guarantor agrees to remain bound under this self-guarantee for as long as it, as licensee, must comply with the applicable financial assurance requirements of 10 CFR Part [insert 30, 40, 70, or 72], for the previously listed facilities, except that the guarantor may cancel this self-guarantee by sending notice by certified mail to the NRC, such cancellation to become effective [if the guarantor is a commercial company that issues bonds, insert “no earlier than 120 days after receipt of such notice by the NRC, as evidenced by the return receipt”] [if the guarantor is a commercial company that does not issue bonds or is a nonprofit college, university, or hospital, insert “not before an alternative financial assurance mechanism has been put in place by the guarantor”].

15. The guarantor agrees that if it, as licensee, fails to provide alternative financial assurance as specified in 10 CFR Part [insert 30, 40, 70, or 72], as applicable, and obtain written approval of such assurance from the NRC within 90 days after a notice of cancellation by the guarantor is received by the NRC from the guarantor, the guarantor shall make full payment under the self-guarantee.

16. The guarantor expressly waives notice of acceptance of this self-guarantee by the NRC. The guarantor also expressly waives notice of amendments or modifications of the decommissioning requirements.

17. If the guarantor files financial reports with the U.S. Securities and Exchange Commission, then it shall promptly submit them to its independent auditor and to the NRC during each year in which this self-guarantee is in effect.

[Insert the following recital only if the guarantor issues bonds]

18. The guarantor agrees that if, at any time before termination of this self-guarantee, its most recent bond issuance ceases to be rated in the category of “A” or above by either Standard & Poor’s or Moody’s, it shall provide notice in writing of such fact to the NRC within 20 days after publication of the change by the rating service.

I hereby certify that this self-guarantee is true and correct to the best of my knowledge.

Effective date: ___________________

[Name of self-guarantor]

[Authorized signature for self-guarantor]

[Name of person signing]

[Title of person signing]

Signature of witness or notary: ____________________

15. EXTERNAL SINKING FUNDS

An *external sinking fund* is a mechanism through which a licensee can gradually prepay for decommissioning by combining the use of a prepayment mechanism (i.e., trust fund, escrow account, government fund, certificate of deposit, or deposit of government securities) with a surety method (i.e., surety bond, letter of credit, or line of credit) or insurance.[32] As the value of the prepayment mechanism increases over time, the amount of coverage provided by the surety method or insurance can be reduced.

The remainder of this section discusses the primary criteria that determine whether particular external sinking fund submissions will be acceptable to NRC.

- Section 15.1 describes qualifications required of the issuer.
- Section 15.2 addresses funding and the adequacy of coverage.
- Section 15.3 discusses the documentation that supports an external sinking fund.

This section also contains a checklist designed to assist licensees in preparing acceptable external sinking funds. Checklist 15-A summarizes the primary criteria used by NRC to evaluate external sinking funds.

15.1 QUALIFICATIONS OF THE ISSUER

As noted above, an external sinking fund combines a prepayment mechanism with a surety method or insurance. These mechanisms may be provided by separate entities or, in some cases, by a single issuer. In all cases, however, issuers of both the prepayment mechanism and the surety method or insurance must meet appropriate qualifications. Information on the qualifications of issuers of prepayment mechanisms is provided in Sections 4 through 8 of this Appendix. Information on the qualifications of issuers of surety methods or insurance is provided in Sections 9 through 12 of this Appendix.

15.2 LEVEL OF COVERAGE

An external sinking fund must be in an amount that, in total, is at least equal to the licensee's certification amount or estimated cost of decommissioning.[33] The prepayment mechanism may be funded initially in any amount. The surety method or insurance must then assure the difference between the prepaid amount and the certification amount or estimated cost of

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[32] Parent company guarantees and self-guarantees may not be used as part of an external sinking fund as these mechanisms may not be used in combination with other forms of financial assurance. In addition, Part 72 licensees that are electric utility licensees (as defined in 10 CFR Part 50) may use an external sinking fund without having to couple it with a surety method or insurance (i.e., they may use a gradually-funded prepayment mechanism only), in which case the amount of the fund may be below the cost estimate or certification amount prior to decommissioning.

[33] The exception to this rule is an external sinking fund submitted by an electric utility licensee, as noted earlier.

CHECKLIST 15-A

EXTERNAL SINKING FUNDS

- ☐ Documentation is complete:
  - ☐ 1. Prepayment mechanism (originally signed duplicate) and all supporting documentation (see Sections 4 through 8 and attach Checklists 4-A through 8-A, as applicable)
  - ☐ 2. Surety method or insurance (originally signed duplicate) and all supporting documentation (see Sections 9 through 12 and attach Checklists 9-A through 12-A, as applicable)
- ☐ The amount of the external sinking fund equals or exceeds the required coverage level.

decommissioning. Subsequently, the licensee must make contributions at least annually to the prepayment mechanism, which increases in value. As the value of the prepayment mechanism increases over time, the amount of coverage provided by the surety method or insurance can be reduced.[34] The total coverage provided by both mechanisms, however, must at all times be at least equal to the licensee's certification amount or estimated cost of decommissioning. If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the external sinking fund, the licensee must revise either the prepayment mechanism or the surety method/insurance so that the combination of the two mechanisms assures the higher amount.

15.3 RECOMMENDED DOCUMENTATION

Licensees who use external sinking funds to provide financial assurance for decommissioning must submit a copy of all documentation supporting the prepayment mechanism (see Sections 4 through 8) <u>and</u> the surety method or insurance (see Sections 9 through 12).

[34] Assets held in the prepayment portion of an external sinking fund must be valued at their *current market value*.

16. STATEMENTS OF INTENT

A *statement of intent* is a commitment by a Federal, State, or local government licensee to request and obtain decommissioning funds from its funding body when necessary. The purpose of a statement of intent is to ensure that, early in the life of their facilities, government licensees make their funding bodies aware of (1) decommissioning requirements and costs and (2) the eventual need for funding. A statement of intent should demonstrate that a government licensee can request special funding from its funding body when necessary. This is different from a guarantee or commitment of a licensee's own funds. Therefore, it is not satisfactory for a licensee to demonstrate that it is authorized to enter into contracts and guarantees committing its own funds, or to promise to allocate funds from its operating budget, from other general appropriations (either current or future), or from other internal resources. A statement of intent must include a site-specific decommissioning cost estimate or a certification statement.

Under the financial assurance regulations (10 CFR 30.35(f)(4), 40.36(e)(4), 70.25(f)(4), and 72.30(c)(4)), a statement of intent may only be used by a Federal, State, or local government *licensee*. However, if a government entity (e.g., a Federal agency) submits a statement of intent on behalf of a non-government licensee, NRC will consider accepting the statement of intent provided that the statement of intent meets all of the guidance outlined in this section, including specification of the dollar amount being assured by the government entity.

The remainder of this section discusses the primary criteria that determine whether a particular statement-of-intent submission will be acceptable to the NRC.

- Section 16.1 describes qualifications required of the issuer.
- Section 16.2 addresses the adequacy of coverage.
- Section 16.3 discusses the documentation that supports a statement of intent.
- Section 16.4 presents a model statement of intent that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees in preparing acceptable statements of intent. Checklist 16-A summarizes the primary criteria used by NRC to evaluate statements of intent. Checklist 16-B (which should be used only by licensees who revise or do not use the wording in the model statements of intent) presents terms and conditions that are recommended for statements of intent.

16.1 QUALIFICATIONS OF THE ISSUER

Under NRC's decommissioning financial assurance regulations (10 CFR 30.35(f)(4), 40.36(e)(4), 70.25(f)(4), and 72.30(c)(4)), only Federal, State, or local government licensees may issue statements of intent to provide financial assurance for decommissioning.

16.2 LEVEL OF COVERAGE

CHECKLIST 16-A

STATEMENTS OF INTENT

- ☐ Documentation is complete:
  - ☐ 1. Statement of intent (originally signed duplicate)
  - ☐ 2. Documentation verifying that the signatory is authorized to represent the licensee in providing the statement of intent
  - ☐ 3. Checklist 16-B (if model statement of intent wording is modified or not used)
- ☐ The amount of the statement of intent equals or exceeds the required coverage level.

A statement of intent must be in an amount that is at least equal to the licensee's certification amount or estimated cost of decommissioning.[35] If the licensee's certification amount or estimated decommissioning cost increases to a level above the amount assured by the statement of intent, the licensee must either (1) revise the statement of intent to assure the higher amount, or (2) obtain another financial assurance mechanism to make up the difference between the new coverage level and the amount of the statement of intent.

16.3 RECOMMENDED DOCUMENTATION

Licensees who use statements of intent to provide financial assurance for decommissioning must submit a copy of the statement of intent and other documentation as discussed below and summarized in Checklist 16-A.[36]

- The *statement of intent* signed by an authorized representative of the licensee. The wording of a statement of intent may vary, but Section 16.4 of this Appendix is a model statement of intent that is acceptable to and recommended by the NRC. Licensees who use other wording should use Checklist 16-B to be sure that their wording contains all the necessary terms and conditions.

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[35] The exception to this rule is a statement of intent that is being combined with another financial mechanism. For a combination of mechanisms, the *sum* of the coverage provided by the mechanisms must be at least equal to the required coverage level.

[36] Supporting documentation may differ for licensees who submit statements of intent that differ from the recommended model.

- Documentation verifying that the person signing the statement of intent is authorized to represent the licensee in the transaction (i.e., has the authority to request and obtain decommissioning funds from the appropriate funding body when necessary).

CHECKLIST 16-B

Terms and Conditions Needed in Decommissioning Statements of Intent

Use this checklist only if deviating from the wording recommended in Section 16.4.

- ☐ Description of authority of government entity to make the statement of intent.
- ☐ Identification of Federal, State, or local government licensee.
- ☐ Description of facility(ies) (name, address, and license number) for which statement of intent provides financial assurance and corresponding costs of required activities.
- ☐ Specification of the amount of funds being assured.
- ☐ Statement that funds for required activities will be requested and obtained from the appropriate funding body when necessary.
- ☐ Recitation of authority to sign the statement of intent.
- ☐ Signatures.
- ☐ Names and titles of signatories.
- ☐ Date.

16.4 MODEL STATEMENT OF INTENT

TO: U.S. Nuclear Regulatory Commission
Washington, DC 20555
[or appropriate regional address]

STATEMENT OF INTENT

As [insert title of signatory] of [insert name of licensee], I exercise express authority and responsibility to request from [insert name of appropriate governmental funding body] funds for decommissioning activities associated with operations authorized by U.S. Nuclear Regulatory Commission Material License No. [insert license number]. This authority is established by [insert name of documents governing control of funds]. Within this authority, I intend to request that funds be made available when necessary in the amount of [insert dollar amount] to decommission [insert facility names, addresses, and estimated costs of required activities or applicable certification amounts]. I intend to request and obtain these funds sufficiently in advance of decommissioning to prevent delay of required activities.

A copy of [insert name of documents] is attached as evidence that I am authorized to represent [insert name of licensee] in this transaction.

[Signature]

[Name]
[Title]
[Date]

Attachment: As stated

17. STANDBY TRUST FUNDS

A *standby trust fund* is simply a trust fund that is not yet funded but is otherwise ready to accept monies in the event they are received from a particular source (such as a surety bond, letter of credit, line of credit, or insurance). Once a standby trust is funded, the funds would then be available to pay the costs of decommissioning, just as they would with an ordinary trust fund. As in the case of an ordinary trust fund, monies in a standby trust fund are legally segregated for a specific purpose and are administered by a trustee with a fiduciary responsibility to keep or use the property in the fund for the benefit of the beneficiary.

Under NRC's decommissioning financial assurance regulations (10 CFR 30.35(f)(2)(ii), 40.36(e)(2)(ii), 70.25(f)(2)(ii), and 72.30(c)(2)(ii)), a standby trust agreement must be established to receive funds from a surety method (i.e., surety bond, letter of credit, line of credit) or insurance. If the funds from these mechanisms were paid directly to NRC rather than to a standby trust fund, NRC would be required to deposit the funds in the U.S. Treasury as general revenue. Consequently, the funds would not be available to pay for decommissioning costs.

The remainder of this section discusses the primary criteria that determine whether particular standby trust fund submissions will be acceptable to NRC.

- Section 17.1 describes qualifications required of the trustee.
- Section 17.2 addresses funding and the adequacy of coverage.
- Section 17.3 discusses the documentation that supports a standby trust fund.
- Section 17.4 presents a model standby trust fund submission that NRC has found to be acceptable.

This section also contains two checklists designed to assist licensees in preparing acceptable decommissioning standby trusts. Checklist 17-A summarizes the primary criteria used by NRC to evaluate standby trust funds. Checklist 17-B (which should be used only by licensees who revise or do not use the model wording for standby trust agreements) presents terms and conditions that are recommended for standby trust agreements.

17.1 QUALIFICATIONS OF THE TRUSTEE

The decommissioning financial assurance regulations (10 CFR 30.35(f)(2)(ii), 40.36(e)(2)(ii), 70.25(f)(2)(ii), and 72.30(c)(2)(ii)) require that the trustee be acceptable to NRC. Acceptable trustees include appropriate State or Federal government agencies and financial institutions that have the authority to act as trustees and whose trust operations are regulated and examined by a Federal or State agency. Trust operations are regulated separately from other banking operations, and it is very common for a regulated bank not to have the authority to act as a trustee. In addition, NRC's requirement for trustees is not usually met by individuals who are not acting as a representative of a financial institution.

CHECKLIST 17-A

STANDBY TRUST FUNDS

- ☐ Documentation is complete:
  - ☐ 1. Standby trust agreement (originally signed duplicate)
  - ☐ 2. Schedule A
  - ☐ 3. Schedule B
  - ☐ 4. Schedule C
  - ☐ 5. Specimen certificate of events
  - ☐ 6. Specimen certificate of resolution
  - ☐ 7. Letter of acknowledgment
  - ☐ 8. Checklist 17-B (if model standby trust wording is modified or not used)
- ☐ The trustee is qualified:
  - ☐ The financial institution is regulated by a Federal or State agency.
  - ☐ The financial institution has authority to act as a trustee and has trust operations that are regulated and examined by a Federal or State agency.

- The word “National” in the title of a financial institution signals that the institution is *Federally regulated*, as do the words “National Association” or the initials “N.A.” following

  its title. To determine whether such a financial institution qualifies as an acceptable trustee, licensees should access the Federal Financial Institutions Examination Council’s (FFIEC) Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

  Alternatively, licensees may contact the appropriate district office of the Office of the Comptroller of the Currency (OCC) and confirm that the institution (1) is Federally regulated <u>and</u> (2) has Federally regulated trust operations. (The OCC’s home page on the World Wide Web is located at http://www.occ.treas.gov.) The six district offices of the OCC, along with the States and territories under their jurisdiction, are as follows:

  - <u>Northeastern District Office</u> (212-819-9860) -- CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT, District of Columbia, Puerto Rico, and Virgin Islands.

  - <u>Southeastern District Office</u> (404-659-8855) -- AL, FL, GA, MS, NC, SC, TN, VA, and WV.

  - <u>Central District Office</u> (312-360-8800) -- IL, IN, KY, MI, OH, and WI.

- Midwestern District Office (816-556-1800) -- IA, KS, MN, MO, NE, ND, and SD.

- Southwestern District Office (214-720-0656) -- AR, LA, OK, and TX.

- Western District Office (415-545-5900) -- AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY, and Guam.

• The word "State" in the title of a financial institution signals that the institution is *State regulated*. U.S. branches of foreign banks are usually regulated by the State in which they are located. To determine whether a State-regulated financial institution qualifies as an acceptable trustee, licensees should access the FFIEC's Trusts Institutions Search database on the World Wide Web at http://www2.fdic.gov/structur/trust/index.html, and look to see that the bank branch has full trust powers.

  Alternatively, licensees may contact the applicable State banking authority and confirm that the institution (1) is State regulated, and (2) has State-regulated trust operations. A directory of State banking authorities can be found on the World Wide Web at http://www.csbsdal.org/info/info.html.

• The titles of some financial institutions do not suggest that they are either Federally regulated or State regulated. In many such cases (but not all), these institutions are State regulated, as are many domestic branches of foreign banks.

The licensee may need or choose to replace the current trustee with a new trustee. To be acceptable to NRC, any successor trustee must meet the same standard as the original trustee (i.e., must be an appropriate State or Federal government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency). To ensure that the change in trustee does not negatively impact the standby trust, the licensee should replace the trustee only after sufficient notification (i.e., 90 days or more) has been provided to both NRC and the current trustee.

17.2 LEVEL OF COVERAGE

Standby trusts generally do not need to contain any money or property at the time they are established.[37] The standby trust should, however, anticipate that it will or may be funded in the full certification amount or estimated decommissioning cost. For example, the standby trust agreement should allow the trustee to access the full level of coverage as appropriate to complete decommissioning activities. (In the model wording for a standby trust agreement, for example, the trustee is authorized to make decommissioning payments only up to the amount listed in Schedule A to the standby trust agreement. If the amount listed in Schedule A is not at least as great as the NRC-approved cost estimate or certification amount, the trustee may not

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[37] State law in some States may require a standby trust fund to contain a de minimis level of funding in order to be effective.

be able to make sufficient payments to complete decommissioning, even if there are sufficient monies in the standby trust.)

If the funds from the licensee's primary financial assurance mechanism are deposited into a standby trust fund, the trust must at all times contain sufficient assets, valued at their *current market value*, to complete decommissioning activities.

17.3 RECOMMENDED DOCUMENTATION

The terms and conditions of a standby trust are governed by a written standby trust agreement. The wording of a standby trust agreement may vary, but Section 17.4 of this Appendix is a model standby trust agreement that would meet NRC's requirements and is recommended by the NRC. In addition to the standby trust agreement, other documentation is to be submitted with a standby trust, as summarized in Checklist 17-A,[38] including the following.

- The *standby trust agreement* (along with any amendments) is the written document that specifies the terms and conditions of the standby trust. The wording contained in the model standby trust in Section 17.4 is acceptable to the NRC. Licensees who use other wording should refer to Checklist 17-B to be sure that the alternative wording contains all the necessary terms and conditions.

- *Schedule A* (Section 17.5) identifies the name and address of the licensee, the NRC license numbers covered by the standby trust, the addresses of the licensed activity, the amount of regulatory assurances demonstrated by the standby trust agreement, and the date on which these amounts were last adjusted and approved by the NRC.

- *Schedule B* (Section 17.5) lists the property (i.e., cash, securities, or other liquid assets) initially used to establish the standby trust fund.[39]

- *Schedule C* (Section 17.5) specifies the compensation to be paid by the licensee to the trustee for its services.

- The *specimen certificate of events* (Section 17.6) and the *specimen certificate of resolution* (Section 17.7) provide the required format for instructing the trustee to release monies from the standby trust in order to fund decommissioning activities at the licensee's facility. When submitted as part of a financial assurance package, the specimen certificates should be unexecuted drafts. (Actual authorization to release funds from the standby trust is accomplished when completed and notarized versions of these certificates are signed by the secretary of the licensee and presented to the trustee.)

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[38] Supporting documentation may differ for licensees who submit standby trusts that differ from the recommended model.

[39] A standby trust may be established with no property in the fund initially. In this case, Schedule B may simply state "none."

- The notarized *letter of acknowledgment* (Section 17.8) verifies the execution of the standby trust agreement and certifies the trustee's signature and authority to enter into the agreement. **17.4 MODEL STANDBY TRUST AGREEMENT**

CHECKLIST 17-B

Terms and Conditions Needed in Decommissioning Standby Trust Agreements

Use this checklist only if deviating from the wording recommended in Section 17.4.

- ☐ Execution date of standby trust.
- ☐ Purpose of standby trust ("whereas" clauses).
- ☐ Statement of licensee's regulatory obligations as reason for the standby trust fund.
- ☐ Grantor or grantors (introductory paragraph).
- ☐ Trustee or trustees (introductory paragraph):
  - ☐ 1. Names and addresses; and
  - ☐ 2. Bank or corporate trustee.
- ☐ Identification of facilities (name, address, and license number) and cost estimates or certification amounts (Section 2 and Schedule A).
- ☐ Words of transfer, conveyance, and delivery in trust (Section 3).
- ☐ Description of trust property (Section 4 and Schedule B):
  - ☐ 1. Cash;
  - ☐ 2. Securities; and/or
  - ☐ 3. Other liquid assets.
- ☐ Additions to trust (Section 4).
- ☐ Distribution of trust principal (Section 5):
  - ☐ 1. Disbursement to licensee upon proper certification;
  - ☐ 2. Payment for activities at NRC's direction in writing;
  - ☐ 3. Refund to grantor at NRC's written specification upon completion of decommissioning; and
  - ☐ 4. Maximum withdrawal of funds at one time for a particular license is limited to 10 percent of the remaining funds available for that license unless NRC written approval is attached.
- ☐ Trust management (Sections 6 - 8):
  - ☐ 1. Discretionary powers;
  - ☐ 2. Fiduciary duty;
  - ☐ 3. Commingling and investment;
  - ☐ 4. Sale or exchange of trust property;
  - ☐ 5. Scope of investments;
  - ☐ 6. Express powers of trustee;
  - ☐ 7. Borrowing money and encumbering trust assets;
  - ☐ 8. Insurance (optional);
  - ☐ 9. Operation of business (optional); and
  - ☐ 10. Compromise of claims (optional).
- ☐ Taxes and expenses (Section 9).
- ☐ Annual valuation (Section 10).
- ☐ Advice of counsel (Section 11).
- ☐ Authority, compensation, and tenure of trustees (Sections 12 - 14):
  - ☐ 1. Trustee compensation (Schedule C);
  - ☐ 2. Successor trustee; and
  - ☐ 3. Instructions to trustee.
- ☐ Amendment of agreement (Section 15).
- ☐ Irrevocability and termination (Section 16).
- ☐ Immunity and indemnification (Section 17).
- ☐ Law to govern construction and operation of trust (Section 18).
- ☐ Interpretation and severability (Section 19).
- ☐ Signatures and titles.
- ☐ Acknowledgments, seals, or attestations, if necessary or desired (witness by notary public).
- ☐ Acceptance of standby trust by trustee or trustees (acknowledgment).

STANDBY TRUST AGREEMENT

TRUST AGREEMENT, the Agreement entered into as of [insert date] by and between [insert name of licensee], a [insert name of State] [insert “corporation,” “partnership,” or “proprietorship”], herein referred to as the “Grantor,” and [insert name and address of a trustee acceptable to NRC], the “Trustee.”

WHEREAS, the U.S. Nuclear Regulatory Commission (NRC), an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has promulgated regulations in Title 10, Chapter I, of the Code of Federal Regulations, Part [insert 30, 40, 70, or 72]. These regulations, applicable to the Grantor, require that a holder of, or an applicant for, a materials license issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72] provide assurance that funds will be available when needed for required decommissioning activities.

WHEREAS, the Grantor has elected to use a [insert “letter of credit,” “line of credit,” “surety bond,” “insurance policy,” “parent company guarantee,” or “self-guarantee”] to provide [insert “all” or “part”] of such financial assurance for the facilities identified herein; and

WHEREAS, when payment is made under a [insert “letter of credit,” “line of credit,” “surety bond,” “insurance policy,” “parent company guarantee,” or “self-guarantee”], this standby trust shall be used for the receipt of such payment; and

WHEREAS, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this Agreement, and the Trustee is willing to act as trustee;

NOW, THEREFORE, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement:

(a) The term “Grantor” means the NRC licensee who enters into this Agreement and any successors or assigns of the Grantor.

(b) The term “Trustee” means the trustee who enters into this Agreement and any successor trustee.

Section 2. Costs of Decommissioning. This Agreement pertains to the costs of decommissioning the materials and activities identified in License Number [insert license number] issued pursuant to 10 CFR Part [insert 30, 40, 70, or 72], as shown in Schedule A.

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a standby trust fund (the Fund) for the benefit of the NRC. The Grantor and the Trustee intend that no third party shall have access to the Fund except as provided herein.

Section 4. Payments Constituting the Fund. Payments made to the Trustee for the Fund shall consist of cash, securities, or other liquid assets acceptable to the Trustee. The Fund is established initially as consisting of the property, which is acceptable to the Trustee, described in Schedule B attached hereto. Such property and any other property subsequently transferred to the Trustee are referred to as the “Fund,” together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible nor shall it undertake any responsibility for the amount of, or adequacy of the Fund, nor any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the NRC.

Section 5. Payment for Required Activities Specified in the Plan. The Trustee shall make payments from the Fund to the Grantor upon presentation to the Trustee of the following:

(a) A certificate duly executed by the Secretary of the Grantor attesting to the occurrence of the events, and in the form set forth in the attached Certificate of Events, and

(b) A certificate attesting to the following conditions:

    (1) that decommissioning is proceeding pursuant to an NRC-approved plan;

    (2) that the funds withdrawn will be expended for activities undertaken pursuant to that plan; and

    (3) that the NRC has been given 30 days prior notice of [insert name of licensee]’s intent to withdraw funds from the trust fund.

No withdrawal from the Fund for a particular license can exceed 10 percent of the remaining funds available for that license unless NRC written approval is attached.

In addition, the Trustee shall make payments from the Fund as the NRC shall direct, in writing, to provide for the payment of the costs of required activities covered by this Agreement. The Trustee shall reimburse the Grantor or other persons as specified by the NRC from the Fund for expenditures for required activities in such amounts as the NRC shall direct in writing. In addition, the Trustee shall refund to the Grantor such amounts as the NRC specifies in writing. Upon refund, such funds shall no longer constitute part of the Fund as defined herein.

Section 6. Trust Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge its duties with respect to the Fund solely in the interest of the beneficiary and with the care, skill, prudence and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; except that:

(a) Securities or other obligations of the Grantor, or any other owner or operator of the facilities, or any of their affiliates as defined in the Investment Company Act of 1940, as amended (15 U.S.C. 80a-2(a)), shall not be acquired or held, unless they are securities or other obligations of the Federal or a State government;

(b) The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the Federal government, and in obligations of the Federal government such as GNMA, FNMA, and FHLM bonds and certificates or State and Municipal bonds rated BBB or higher by Standard & Poor's or Baa or higher by Moody's Investment Services; and

(c) For a reasonable time, not to exceed 60 days, the Trustee is authorized to hold uninvested cash, awaiting investment or distribution, without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:

(a) To transfer from time to time any or all of the assets of the Fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other trusts participating therein; and

(b) To purchase shares in any investment company registered under the Investment Company Act of 1940 (15 U.S.C. 80a-1 et seq.), including one that may be created, managed, underwritten, or to which investment advice is rendered, or the shares of which are sold by the Trustee. The Trustee may vote such shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretion conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

(a) To sell, exchange, convey, transfer, or otherwise dispose of any property held by it, by public or private sale, as necessary to allow duly authorized withdrawals at the joint request of the Grantor and the NRC or to reinvest in securities at the direction of the Grantor;

(b) To make, execute, acknowledge, and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

(c) To register any securities held in the Fund in its own name, or in the name of a nominee, and to hold any security in bearer form or in book entry, or to combine certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, to reinvest interest payments and funds from matured and redeemed instruments, to file proper forms concerning securities held in the Fund in a timely fashion with appropriate government agencies, or to deposit or arrange for the deposit of such securities in a qualified central depository even though, when so deposited, such securities may be merged and held in bulk in the name of the nominee or such depository with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the U.S. Government, or any agency or instrumentality thereof, with a Federal Reserve Bank, but the books and records of the Trustee shall at all times show that all such securities are part of the Fund;

(d) To deposit any cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal government; and

(e) To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 10. Annual Valuation. After payment has been made into this standby trust fund, the Trustee shall annually, at least 30 days before the anniversary date of receipt of payment into the standby trust fund, furnish to the Grantor and to the NRC a statement confirming the value of the Trust. Any securities in the Fund shall be valued at market value as of no more than 60 days before the anniversary date of the establishment of the Fund. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the NRC shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to the matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting on the advice of counsel.

Section 12. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing with the Grantor. (See Schedule C.)

Section 13. Successor Trustee. Upon 90 days notice to the NRC and the Grantor, the Trustee may resign; upon 90 days notice to NRC and the Trustee, the Grantor may replace the Trustee; but such resignation or replacement shall not be effective until the Grantor has appointed a successor Trustee, the successor accepts the appointment, the successor is ready to assume its duties as trustee, and NRC has agreed, in writing, that the successor is an appropriate State or Federal government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency. The successor Trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. When the resignation or replacement is effective, the Trustee shall assign, transfer, and pay over to the successor Trustee the funds and properties then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor Trustee or for instructions. The successor Trustee shall specify the date on which it assumes administration of the trust, in a writing sent to the Grantor, the NRC, and the present Trustee, by certified mail 10 days before such change becomes effective. Any expenses incurred by the

Trustee as a result of any of the acts contemplated by this section shall be paid as provided in Section 9.

Section 14. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by such persons as are signatories to this Agreement or such other designees as the Grantor may designate in writing. The Trustee shall be fully protected in acting without inquiry in accordance with the Grantor's orders, requests, and instructions. If the NRC issues orders, requests, or instructions to the Trustee these shall be in writing, signed by the NRC or its designees, and the Trustee shall act and shall be fully protected in acting in accordance with such orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the NRC hereunder has occurred. The Trustee shall have no duty to act in the absence of such orders, requests, and instructions from the Grantor and/or the NRC, except as provided for herein.

Section 15. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee, and the NRC, or by the Trustee and the NRC if the Grantor ceases to exist. All amendments shall meet the relevant regulatory requirements of the NRC.

Section 16. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 15, this trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the NRC, or by the Trustee and the NRC if the Grantor ceases to exist. Upon termination of the trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor or its successor.

Section 17. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this trust, or in carrying out any directions by the Grantor or the NRC issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor or from the trust fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 18. This Agreement shall be administered, construed, and enforced according to the laws of the State of [insert name of State].

Section 19. Interpretation and Severability. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement. If any part of this Agreement is invalid, it shall not affect the remaining provisions which will remain valid and enforceable.

IN WITNESS WHEREOF the parties have caused this Agreement to be executed by the respective officers duly authorized and the incorporate seals to be hereunto affixed and attested as of the date first written above.

[Insert name of licensee (Grantor)]
[Signature of representative of Grantor]
[Title]

ATTEST:
[Title]
[Seal]

[Insert name of Trustee]
[Signature of representative of Trustee]
[Title]

ATTEST:
[Title]
[Seal]

17.5 MODEL STANDBY TRUST AGREEMENT SCHEDULES

Schedule A

This Agreement demonstrates financial assurance for the following cost estimates or certification amounts for the following licensed activities:

U.S. NUCLEAR REGULATORY COMMISSION LICENSE NUMBER(S)	NAME AND ADDRESS OF LICENSEE	ADDRESS OF LICENSED ACTIVITY	COST ESTIMATES FOR REGULATORY ASSURANCES DEMONSTRATED BY THIS AGREEMENT

The cost estimates listed here were last adjusted and approved by the NRC on [insert date].

Schedule B

DOLLAR AMOUNT_____________

AS EVIDENCED BY______________

Schedule C

Trustee’s fees shall be $________________ per year.

17.6 MODEL SPECIMEN CERTIFICATE OF EVENTS

[Insert name and address of trustee]

Attention: Trust Division

Gentlemen:

In accordance with the terms of the Agreement with you dated _________, I, _________, Secretary of [insert name of licensee], hereby certify that the following events have occurred:

1. [Insert name of licensee] is required to commence the decommissioning of its facility located at [insert location of facility] (hereinafter called the decommissioning).

2. The plans and procedures for the commencement and conduct of the decommissioning have been approved by the United States Nuclear Regulatory Commission, or its successor, on __________ (copy of approval attached).

3. The Board of Directors of [insert name of licensee] has adopted the attached resolution authorizing the commencement of the decommissioning.

____
Secretary of [insert name of licensee]

____
Date

17.7 MODEL SPECIMEN CERTIFICATE OF RESOLUTION

I, __________, do hereby certify that I am Secretary of [insert name of licensee], a [insert State of incorporation] corporation, and that the resolution listed below was duly adopted at a meeting of this Corporation's Board of Directors on __________, 19___.

IN WITNESS WHEREOF, I have hereunto signed my name and affixed the seal of this Corporation this ___ day of _________, 19___.

____
Secretary

RESOLVED, that this Board of Directors hereby authorizes the President, or such other employee of the Company as he may designate, to commence decommissioning activities at [insert name of facility] in accordance with the terms and conditions described to this Board of Directors at this meeting and with such other terms and conditions as the President shall approve with and upon the advice of Counsel.

17.8 MODEL LETTER OF ACKNOWLEDGMENT

STATE OF ________________

To Wit: ________________

CITY OF ________________

On this ___ day of ____________, before me, a notary public in and for the city and State aforesaid, personally appeared ____________, and she/he did depose and say that she/he is the [insert title] of ____________ [if applicable, insert ", national banking association" or ", State banking association"], Trustee, which executed the above instrument; that she/he knows the seal of said association; that the seal affixed to such instrument is such corporate seal; that it was so affixed by order of the association; and that she/he signed her/his name thereto by like order.

____
[Signature of notary public]

My Commission Expires: ___________
[Date]

18. FINANCIAL ASSURANCE DEMONSTRATIONS INCLUDED IN A DECOMMISSIONING PLAN

At the end of licensed operations, licensees must maintain all decommissioning financial assurance established pursuant to 10 CFR 30.35, 40.36, 70.25, or 72.30. In addition, licensees must submit a decommissioning plan pursuant to 10 CFR 30.36, 40.42, 70.38, or 72.54 if (1) such a plan is required by a license condition, or (2) the procedures and activities necessary to carry out decommissioning (and, if applicable, site control and maintenance) have not been approved by NRC and these procedures could increase the potential health and safety impacts to workers or the public.

The purpose of this section is to provide general guidance to licensees on preparing the financial assurance demonstration that is to be included as part of a decommissioning plan under 10 CFR 30.36, 40.42, 70.38, and 72.54. The decommissioning financial assurance demonstration must include (1) an updated, detailed cost estimate for decommissioning and, if the license is being terminated under restricted conditions, for control and maintenance of the site following license termination; (2) one or more financial assurance mechanisms (including supporting documentation); (3) a comparison of the cost estimate to the level of coverage provided by the financial assurance mechanisms; and (4) if applicable, a description of the means to be employed for adjusting the cost estimate and associated funding level over any storage or surveillance period. These requirements are summarized below in Checklist 18.

In preparing cost estimates for inclusion in decommissioning plans, licensees should refer to the detailed guidance and cost estimating tables in Section 3 of this Appendix, and to the supplementary guidance included below. In preparing financial assurance mechanisms for inclusion in decommissioning plans, licensees should refer to the detailed guidance, checklists, and recommended wording in Sections 4 through 16 of this Appendix, as well as the supplementary guidance included below.

The remainder of this section is divided into two parts. Section 18.1 addresses financial assurance demonstrations in cases where the license will be terminated for unrestricted release. Section 18.2 addresses financial assurance demonstrations in cases where the license will be terminated under restricted conditions.

CHECKLIST 18

DECOMMISSIONING PLANS

License Number(s): ______________________________

Applicable Parts of 10 CFR (check all that apply): ☐ Part 30 ☐ Part 40 ☐ Part 70 ☐ Part 72

License will be terminated: ☐ For unrestricted release (see Section 18.1) ☐ Under restricted conditions (see Section 18.2)

- ☐ Prepare an updated site-specific cost estimate (see Section 3, and Section 18.1.1 or 18.2.1)
- ☐ Prepare a financial assurance mechanism (see Sections 4 through 16, and Section 18.1.2 or 18.2.2)
- ☐ Compare the cost estimate to the level of financial assurance provided (see Section 18.1.3 or 18.2.3)
- ☐ Determine the means that will be used to adjust the site-specific cost estimate and associated funding level over any storage or surveillance period (see Section 18.1.4 or 18.2.4)
- ☐ Include the necessary documentation:
  - ☐ Updated, detailed, site-specific cost estimate
  - ☐ Description of the means that will be used to adjust the site-specific cost estimate and associated funding level
  - ☐ Comparison of the cost estimate to the level of coverage provided by the financial assurance mechanism(s)
  - ☐ Financial instrument(s) and supporting documentation

18.1 LICENSE TERMINATION FOR UNRESTRICTED RELEASE

18.1.1 Decommissioning Cost Estimate

Cost estimates included in a decommissioning plan for license termination for unrestricted release are similar in many respects to those required for decommissioning funding plans (DFPs) submitted at the time of license application or renewal. As a result, licensees should refer to the detailed guidance in Section 3 of this Appendix for specific instructions on preparing a cost estimate.

Licensees that have already prepared cost estimates as part of DFPs do not need to prepare entirely new cost estimates for inclusion in their decommissioning plans. Rather, to reduce burden, these licensees may simply update their existing cost estimates to reflect any changes that have occurred since the estimate was last submitted to NRC. Cost estimates should be updated to reflect completed decommissioning activities, current contamination levels, inflation, changes in waste disposal costs and other prices of goods and services, changes in decommissioning procedures, and any other changes in facility conditions. In order to facilitate NRC's review, licensees should prepare documentation explaining in detail how the cost estimate has been updated. Licensees should also ensure that the updated cost estimate includes all of the items called for in Section 3 of this Appendix.

Licensees that have not already prepared a decommissioning cost estimate (e.g., because they had previously been using a certification of financial assurance) should prepare the cost estimate using the guidance above as well as the guidance and cost estimating tables contained in Section 3 of this Appendix.

18.1.2 Financial Assurance Mechanism

As specified in 10 CFR 30.36(e), 40.42(e), 70.38(e), and 72.54(e), licensees must maintain financial assurance for decommissioning until the license has been terminated. The amount of this financial assurance must be adjusted as necessary to cover the updated cost estimate for decommissioning. (The text of the financial assurance mechanism(s) could remain unchanged in this case.)

Alternatively, licensees may choose to provide a new financial assurance mechanism in place of their previous mechanism(s). In preparing the new mechanism, licensees should consult the guidance provided in Sections 4 through 16 of this Appendix, as applicable. The new mechanism would need to be in an amount that is at least as great as the updated cost estimate for decommissioning.

Acceptable mechanisms for providing financial assurance for decommissioning include the following:

- Trust funds → see Section 4
- Escrow accounts → see Section 5
- government funds → see Section 6
- Certificates of deposit → see Section 7
- Deposits of government securities → see Section 8
- Surety bonds → see Section 9
- Letters of credit → see Section 10
- Lines of credit → see Section 11
- Insurance policies → see Section 12
- Parent company guarantees → see Section 13
- Self-guarantees → see Section 14
- External sinking funds → see Section 15
- Statements of intent → see Section 16

18.1.3 Comparison of the Cost Estimate to the Current Level of Financial Assurance

The decommissioning plan must include a comparison of the amount of the updated cost estimate for decommissioning to the amount of coverage provided by the licensee's financial assurance mechanism(s). If the cost estimate exceeds the financial assurance coverage, the licensee must increase the amount of coverage to at least the amount of the cost estimate. If the cost estimate is less than the financial assurance coverage, the licensee may retain the current level of coverage or reduce the level of coverage as appropriate.

18.1.4 Means for Adjusting the Cost Estimate and Associated Funding Level

The decommissioning plan must include a description of the means the licensee will employ for adjusting the cost estimate and associated funding level over any storage or surveillance period. In general, the cost estimate should be adjusted to account for completed decommissioning activities, for inflation and other changes in the prices of goods and services (e.g., waste disposal cost increases), for changes in facility conditions, and for changes in decommissioning procedures. As discussed above, if at any time the cost estimate exceeds the financial assurance coverage, the licensee must increase the amount of coverage to at least the amount of the cost estimate.

18.2 LICENSE TERMINATION UNDER RESTRICTED CONDITIONS

18.2.1 Cost Estimate for Decommissioning and Site Control/Maintenance

Cost estimates included in a decommissioning plan for license termination under restricted conditions are similar in many respects to those required for decommissioning funding plans (DFPs) submitted at the time of license application or renewal. As a result, licensees should refer to the detailed guidance in Section 3 of this Appendix for specific instructions on preparing a cost estimate.

<u>Costs for Site Control and Maintenance</u>

In addition to costs for standard decommissioning activities, the cost estimate also must include costs for site control and maintenance activities. These estimated costs should be sufficient to allow an independent third party to conduct site control and maintenance activities if the site landowner is unwilling or unable to do so.[40]

The primary component of site control and maintenance costs is the cost associated with institutional controls, including proprietary institutional controls, governmental institutional controls, and physical controls. Proprietary institutional controls include easements, restrictive covenants, equitable servitudes, reverter clauses, and government ownership of land. Governmental institutional controls include zoning, deed restrictions, water supply restrictions, building permit requirements, and property law regulations. Physical controls include fences,

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[40] Control and maintenance of a site would not necessarily have to be carried out by an independent third party. For example, the site landowner (who may be the former licensee) may carry out such activities if capable, and could be paid directly from the financial assurance funds provided for performing the work, if appropriate.

markers, and earthen covers. At a minimum, the following costs should be estimated for the institutional controls that will be employed at the site:

- Establishment and Implementation. The cost estimate should include the costs of putting institutional controls into place (e.g., construction costs for physical barriers).

- Enforcement. Mechanisms for enforcement of controls include periodic inspection, surveys, control, monitoring, and maintenance of physical barriers at the site; inspections of the property; and maintenance of deed restrictions and monitoring of deed compliance.

- Recordkeeping. The party responsible for site control and maintenance should maintain records containing at least (1) a legal description of the property, (2) the name or names of the current owners of the property as reflected in public land records, (3) identification of the parties who can enforce the restrictions, (4) the reason for the restrictions, (5) the duration of the restrictions, (7) permission to install and maintain physical controls, if any are used, (8) the location of a copy of the final radiation status report that is available for public inspection, and (9) official actions and financial payments.

- Periodic Site Checks. Under 10 CFR 20.1403(e)(2)(iii), the party responsible for site control and maintenance must perform periodic checks of the site no less frequently than every five years by to ensure that the institutional controls continue to function effectively. The periodic checks should include an on-site inspection to verify that prohibited activities are not being conducted. Also, although a review of the deed to ensure that deed restrictions are still in place is usually not necessary, the deed should be reviewed if there is any cause to believe that the restrictions are not still properly part of the deed.

- Corrective Actions. In some cases, corrective actions must be taken in the event a restriction needs to be broken.[41] For example, a “no excavation” restriction may need to be broken if a water main under the site bursts and must be repaired.

The cost estimate for site control and maintenance should be consistent with the amount of radioactivity remaining at the site, the radionuclides involved, the characteristics of the residual radioactivity at the site, and site-specific exposure scenarios, pathways, and parameters. The estimate should include adequate periods of site control and should account for all associated costs during this period. Finally, the estimate should be based on activities that are sufficient to prevent the annual dose to the average member of the critical group from exceeding 25 mrem (0.25 mSv).

Preparing the Cost Estimate

[41] Because the need for corrective actions cannot be predicted, costs for these activities cannot be explicitly accounted for in the cost estimate. Rather, the cost estimate should include a sufficient contingency factor to cover these costs.

Licensees that have already prepared cost estimates as part of DFPs do not need to prepare entirely new cost estimates for inclusion in their decommissioning plans. Rather, to reduce burden, these licensees may simply update their existing cost estimates to reflect (1) the costs associated with site control and maintenance, and (2) any changes that have occurred since the estimate was last submitted to NRC. Cost estimates should be updated to reflect completed decommissioning activities, current contamination levels, inflation, changes in waste disposal costs and other prices of goods and services, changes in decommissioning procedures, and any other changes in facility conditions. In order to facilitate NRC's review, licensees should prepare documentation explaining in detail how the cost estimate has been updated. Licensees should also ensure that the updated cost estimate includes all of the items called for in Section 3 of this Appendix.

Licensees that have not already prepared a decommissioning cost estimate (e.g., because they had previously been using a certification of financial assurance) should prepare the cost estimate using the guidance above as well as the guidance and cost estimating tables contained in Section 3 of this Appendix.

18.2.2 Financial Assurance Mechanism

As specified in 10 CFR 30.36(e), 40.42(e), 70.38(e), and 72.54(e), licensees must maintain financial assurance for decommissioning until the license has been terminated. The amount of this financial assurance must be adjusted as necessary to cover the updated cost estimate for decommissioning.

In addition, pursuant to 10 CFR 20.1403(c), licensees requesting license termination under restricted conditions must also provide financial assurance for site control and maintenance. If a licensee wishes to use its existing decommissioning financial assurance mechanism(s) to provide coverage for site control and maintenance, the text of the mechanism(s) would need to be changed as necessary to reflect its applicability to site control and maintenance activities. Also, the amount of coverage provided by the mechanism(s) would need to be adjusted to cover the estimated costs for site control and maintenance.

Alternatively, licensees may choose to provide a new, separate mechanism to cover site control and maintenance costs, or may provide a new financial assurance mechanism to cover both decommissioning and site control and maintenance costs. In preparing the new mechanism(s), licensees should consult the guidance provided in Sections 4 through 16 of this Appendix, as applicable. The new mechanism(s) would need to be in an amount that is at least as great as the updated cost estimate for decommissioning and site control and maintenance.

Acceptable mechanisms for providing financial assurance for decommissioning and site control and maintenance include special arrangements with a government entity, as described later in this section, as well as the following mechanisms, which are explained in earlier sections of this Appendix:

- Trust funds → see Section 4
- Escrow accounts → see Section 5
- government funds → see Section 6
- Certificates of deposit → see Section 7

- Deposits of government securities → see Section 8
- Surety bonds → see Section 9
- Letters of credit → see Section 10
- Lines of credit → see Section 11
- Insurance policies → see Section 12
- Parent company guarantees → see Section 13
- Self-guarantees → see Section 14
- External sinking funds → see Section 15
- Statements of intent → see Section 16

Regardless of the mechanism used, the licensee or custodian for the site should permit public access to records on financing for site controls and maintenance. These records should be available for inspection by the public for a period of 25 years.

Special Arrangements with a Government Entity

In addition to the mechanisms listed above, licensees may provide financial assurance through a special arrangement deemed acceptable by a governmental entity when the governmental entity assumes custody and ownership of a site. Licensees choosing to use such an arrangement should submit documentation of the terms and conditions governing the arrangement. Also, the government entity with whom the arrangement is made should have the authority to receive and hold funds for specified purposes (e.g., decommissioning, site control and maintenance). Checklist 18-A below summarizes the primary criteria used by NRC to evaluate special arrangements.

CHECKLIST 18-A

SPECIAL ARRANGEMENTS WITH A GOVERNMENT ENTITY

- ☐ Documentation of the arrangement is provided.
- ☐ The government entity has the authority to receive and hold funds for specified purposes.
- ☐ The amount of financial assurance provided by the arrangement equals or exceeds the required coverage level.

18.2.3 Comparison of the Cost Estimate to the Current Level of Financial Assurance

The decommissioning plan must include a comparison of the amount of the updated cost estimate for decommissioning and site control and maintenance with the amount of coverage provided by the licensee's financial assurance mechanism(s). In determining the amount of financial assurance coverage for site control and maintenance (but not decommissioning), licensees may assume a real (i.e., inflation adjusted), after-tax rate of return of up to 2 percent per year if funds are set aside in an account (e.g., a trust or escrow) segregated from the licensee's assets and outside its administrative control.[42] If the cost estimate exceeds the financial assurance coverage, the licensee must increase the amount of coverage to at least the amount of the cost estimate. If the cost estimate is less than the financial assurance coverage, the licensee may retain the current level of coverage or reduce the level of coverage as appropriate.

18.2.4 Means for Adjusting the Cost Estimate and Associated Funding Level

The decommissioning plan must include a description of the means the licensee will employ for adjusting the cost estimate and associated funding level over any storage or surveillance period. In general, the cost estimate should be adjusted to account for completed decommissioning activities, for inflation and other changes in the prices of goods and services (e.g., waste disposal cost increases), for changes in facility conditions, and for changes in procedures for decommissioning and/or site control and maintenance. As discussed above, if at any time the cost estimate exceeds the financial assurance coverage, the licensee must increase the amount of coverage to at least the amount of the cost estimate.

[42] The rationale for the value of 2 percent per year is taken from the proposed rule entitled "Financial Assurance Requirements for Decommissioning Nuclear Power Reactors" (62 *Federal Register* 47588; September 10, 1997). Credit for earnings may not be taken for mechanisms (e.g., letter of credit, surety bond, guarantee, insurance) that do not set funds aside in advance to pay the obligation.

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ATTACHMENT 1

Table for Determining Financial Assurance Requirements Under 10 CFR Parts 30, 40, and 70 by Type of Isotope and Activity Level

ISOTOPE	Sealed Sources/ Plated Foils under 10 CFR Part 30		Unsealed Sources under 10 CFR Parts 30, 40, and 70			
	Financial Assurance Not Required	$75,000 Certification Allowed	Financial Assurance Not Required	$150,000 Certification Allowed	$750,000 Certification Allowed	DFP Required
Americium-241	≤100 Ci	>100 Ci	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Antimony-125	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Barium-133	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Bismuth-210	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Cadmium-109	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Calcium-45	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Carbon-14	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Cerium-144	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Cesium-134	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Cesium-135	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Cesium-137	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Chlorine-36	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Cobalt-60	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Europium-152 13yr	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Europium-154	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Europium-155	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Gadolinium-153	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci

ISOTOPE	*Sealed Sources/ Plated Foils under 10 CFR Part 30*		*Unsealed Sources under 10 CFR Parts 30, 40, and 70*			
	Financial Assurance Not Required	**$75,000 Certification Allowed**	**Financial Assurance Not Required**	**$150,000 Certification Allowed**	**$750,000 Certification Allowed**	**DFP Required**
Holmium-166	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Hydrogen-3	≤10,000,000 Ci	>10,000,000 Ci	≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci, ≤100 Ci	>100 Ci
Indium-115	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Iodine-129	≤1,000 Ci	>1,000 Ci	≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi
Iron-55	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Krypton-85	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Manganese-54	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Nickel-59	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Nickel-63	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Niobium-93m	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Platinum-193	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Plutonium-239	-	-	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Polonium-210	≤1,000 Ci	>1,000 Ci	≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi
Promethium-147	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Radium-226	≤100 Ci	>100 Ci	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Rubidium-87	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Ruthenium-106	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi

ISOTOPE	*Sealed Sources/ Plated Foils under 10 CFR Part 30*		*Unsealed Sources under 10 CFR Parts 30, 40, and 70*			
	Financial Assurance Not Required	**$75,000 Certification Allowed**	**Financial Assurance Not Required**	**$150,000 Certification Allowed**	**$750,000 Certification Allowed**	**DFP Required**
Samarium-151	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Silver-110m	≤10,000 Ci	>10,000 Ci	≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi
Strontium-90	≤1,000 Ci	>1,000 Ci	≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi
Technetium-97	≤1,000,000 Ci	>1,000,000 Ci	≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci, ≤10 Ci	>10 Ci
Technetium-99	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Thallium-204	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Thorium (natural)	-	-	≤10 mCi	>10 mCi, ≤100 mCi	-	>100 mCi
Thulium-170	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Thulium-171	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Tungsten-181	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Uranium (natural)	-	-	≤10 mCi	>10 mCi, ≤100 mCi	-	>100 mCi
Uranium-233	-	-	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Uranium-234/235	-	-	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Zinc-65	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci
Zirconium-93	≤100,000 Ci	>100,000 Ci	≤10 mCi	>10 mCi, ≤100 mCi	>100 mCi, ≤1 Ci	>1 Ci

ISOTOPE	*Sealed Sources/ Plated Foils under 10 CFR Part 30*		*Unsealed Sources under 10 CFR Parts 30, 40, and 70*			
	Financial Assurance Not Required	**$75,000 Certification Allowed**	**Financial Assurance Not Required**	**$150,000 Certification Allowed**	**$750,000 Certification Allowed**	**DFP Required**
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition (with a half-life greater than 120 days)	≤100 Ci	>100 Ci	≤0.01 mCi	>0.01 mCi, ≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition (with a half-life greater than 120 days)	≤1,000 Ci	>1,000 Ci	≤0.1 mCi	>0.1 mCi, ≤1 mCi	>1 mCi, ≤10 mCi	>10 mCi

ATTACHMENT 2

APPENDIX B TO 10 CFR PART 30
Quantities[1] of Licensed Material Requiring Labeling

Material	Microcuries	Material	Microcuries	Material	Microcuries	Material	Microcuries
Americium-241	0.01	Gadolinium-159	100	Osmium-191	100	Tantalum-182	10
Antimony-122	100	Gallium-72	10	Osmium-193	100	Technetium-96	10
Antimony-124	10	Germanium-71	100	Palladium-103	100	Technetium-97m	100
Antimony-125	10	Gold-198	100	Palladium-109	100	Technetium-97	100
Arsenic-73	100	Gold-199	100	Phosphorus-32	10	Technetium-99m	100
Arsenic-74	10	Hafnium-181	10	Platinum-191	100	Technetium-99	10
Arsenic-76	10	Holmium-166	100	Platinum-193m	100	Tellurium-125m	10
Arsenic-77	100	Hydrogen-3	1,000	Platinum-193	100	Tellurium-127m	10
Barium-131	10	Indium-113m	100	Platinum-197m	100	Tellurium-127	100
Barium-133	10	Indium-114m	10	Platinum-197	100	Tellurium-129m	10
Barium-140	10	Indium-115m	100	Plutonium-239	0.01	Tellurium-129	100
Bismuth-210	1	Indium-115	10	Polonium-210	0.1	Tellurium-131m	10
Bromine-82	10	Iodine-125	1	Potassium-42	10	Tellurium-132	10
Cadmium-109	10	Iodine-126	1	Praseodymium-142	100	Terbium-160	10
Cadmium-115m	10	Iodine-129	0.1	Praseodymium-143	100	Thallium-200	100
Cadmium-115	100	Iodine-131	1	Promethium-147	10	Thallium-201	100
Calcium-45	10	Iodine-132	10	Promethium-149	10	Thallium-202	100
Calcium-47	10	Iodine-133	1	Radium-226	0.01	Thallium-204	10
Carbon-14	100	Iodine-134	10	Rhenium-186	100	Thorium(natural)[1]	100
Cerium-141	100	Iodine-135	10	Rhenium-188	100	Thulium-170	10
Cerium-143	100	Iridium-192	10	Rhodium-103m	100	Thulium-171	10
Cerium-144	1	Iridium-194	100	Rhodium-105	100	Tin-113	10
Cesium-131	1,000	Iron-55	100	Rubidium-86	10	Tin-125	10
Cesium-134m	100	Iron-59	10	Rubidium-87	10	Tungsten-181	10
Cesium-134	1	Krypton-85	100	Ruthenium-97	100	Tungsten-185	10
Cesium-135	10	Krypton-87	10	Ruthenium-103	10	Tungsten-187	100
Cesium-136	10	Lanthanum-140	10	Ruthenium-105	10	Uranium(natural)[2]	100
Cesium-137	10	Lutetium-177	100	Ruthenium-106	1	Uranium-233	0.01
Chlorine-36	10	Manganese-52	10	Samarium-151	10	Uranium-234	0.01
Chlorine-38	10	Manganese-54	10	Samarium-153	100	Uranium-235	0.01
Chromium-51	1,000	Manganese-56	10	Scandium-46	10	Vanadium-48	10
Cobalt-58m	10	Mercury-197m	100	Scandium-47	100	Xenon-131m	1,000
Cobalt-58	10	Mercury-197	100	Scandium-48	10	Xenon-133	100
Cobalt-60	1	Mercury-203	10	Selenium-75	10	Xenon-135	100
Copper-64	100	Molybdenum-99	100	Silicon-31	100	Ytterbium-175	100
Dysprosium-165	10	Neodymium-147	100	Silver-105	10	Yttrium-90	10
Dysprosium-166	100	Neodymium-149	100	Silver-110m	1	Yttrium-91	10
Erbium-169	100	Nickel-59	100	Silver-111	100	Yttrium-92	100
Erbium-171	100	Nickel-63	10	Sodium-24	10	Yttrium-93	100
Europium-152 9.2 h	100	Nickel-65	100	Strontium-85	10	Zinc-65	10
Europium-152 13 yr	1	Niobium-93m	10	Strontium-89	1	Zinc-69m	100
Europium-154	1	Niobium-95	10	Strontium-90	0.1	Zinc-69	1,000
Europium-155	10	Niobium-97	10	Strontium-91	10	Zirconium-93	10
Fluorine-18	1,000	Osmium-185	10	Strontium-92	10	Zirconium-95	10
Gadolinium-153	10	Osmium-191m	100	Sulphur-35	100	Zirconium-97	10

Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition. 0.01
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition. 0.1

[1] Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.
[2] Based on alpha disintegration rate of U-238, U-234, and U-235.
NOTE: For purposes of §20.303, where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed “1” (i.e., “unity”).

APPENDIX G

SPECIFIC REVIEW PROCESS GUIDELINES

APPENDIX G
SPECIFIC REVIEW PROCESS GUIDELINES

1. Cost Estimates for Decommissioning and Site Control and Maintenance

1. Before the site-specific cost estimate can be reviewed, the license reviewer or licensing project manager will review the cost estimate to verify that the contamination sources assumed in the cost estimate are reasonable, based on the license reviewer's or licensing project manager's knowledge of the site and site operations:

   - If the contamination sources are reasonable, the license reviewer or licensing project manager may either conduct a technical review of the cost estimate or prepare a Technical Assistance Request (TAR) to the Branch Chief of the Decommissioning Branch (DCB), for the review of the site-specific cost estimate by DCB staff.

   - If there are deficiencies in the assumed contamination sources, the license reviewer or licensing project manager will make a decision on whether there is sufficient information in the submittal to warrant a review of the cost estimate. For DCB TARs, if there is sufficient information, the license reviewer or licensing project manager will prepare a note describing the source deficiencies so that DCB staff comments appropriately consider this information.

2. The reviewer will provide a memorandum documenting the review of the cost estimate. If there are any deficiencies, the reviewer will provide specific comments for inclusion into a deficiency letter, which will be prepared by the license reviewer or licensing project manager.

2. Certification Statements

- The license reviewer will compare the wording of the certification statement to the recommended wording contained in Section 2 of Appendix F to this Standard Review Plan (SRP). If the wording is identical, the certification statement is acceptable. If the wording is not identical, the reviewer will verify that the certification statement includes all necessary information, including the name of the licensee, the locations of the facilities for which financial assurance is provided, the amount and types of materials authorized for possession under the license, and the certification amount(s).

3. The reviewer will provide a memorandum documenting the review of the certification statement. If there are any deficiencies, the reviewer will provide specific comments for inclusion into a deficiency letter, which will be prepared by the license reviewer or licensing project manager.

3. Financial Assurance Mechanisms

3.1 General Guidelines

4. On receipt of a licensee's financial assurance instrument, the license reviewer or licensing project manager will enter the financial assurance information (including type of mechanism, amount of mechanism, expiration date, and name and address of issuer) into the License Tracking System (LTS), and will update existing information as necessary. The license reviewer or licensing project manager will use standard regional or division procedures for entering information into the LTS.

5. The license reviewer or licensing project manager will secure all financial assurance instruments in a safe in accordance with Management Directive 8.12, "Decommissioning Financial Assurance Instrument Security Program."

6. The license reviewer or licensing project manager will forward copies of all parent company guarantees, self-guarantees, certificates of deposit, insurance policies, and special arrangements with a government entity to DCB for review via a Technical Assistance Request (TAR). DCB, the Office of the General Counsel (OGC), and contractor staff will review these submittals to ensure that the supporting financial information provided with the instrument is correct and complete. (See Sections 3.2 and 3.3 below.)

7. In all other cases, the license reviewer or licensing project manager will review the financial assurance instrument(s) submitted by the licensee to ensure that instrument(s) meets all applicable regulatory requirements. If the mechanism is identical to the recommended wording in Appendix F to this SRP, the mechanism is acceptable. If there are only minor differences in the wording, the Region may forward the mechanism to its Regional Counsel for review. In all other cases, a TAR should be prepared for DCB review. If there are questions about the wording of financial instruments or about documentation, the reviewing staff will consult the appropriate NRC office for assistance. (See Section 3.4 below.)

8. If requested, via a TAR, to review a submission, the DCB staff will provide a memorandum documenting the review of the financial assurance instrument(s) to the license reviewer or licensing project manager. If there are any deficiencies, the staff will provide specific comments for inclusion into a deficiency letter, which will be prepared by the license reviewer or licensing project manager.

3.2 Specific Guidelines for Certificates of Deposit, Parent Company Guarantees, and Self-Guarantees

NOTE: ***As stated above, all certificates of deposit, parent company guarantees, and self-guarantees should be forwarded to DCB for review via a TAR (although Regions may also conduct their own separate reviews). This section outlines the procedures for review of the submittal by DCB staff.***

9. DCB staff will verify that all of the necessary items (as identified in Section 15.3.3 above) have been included in the submission. If any necessary items are not included, the staff will obtain the missing items from the licensee. (Note: At the staff's discretion, the request for the missing items may be postponed until other deficiencies, if any, have been identified.)

10. DCB staff will compare the wording of the mechanism (including all attachments) to the recommended wording contained in Appendix F to this SRP. The submitted wording is acceptable if it is identical to the recommended wording. If the submitted wording is not identical, the staff will determine (with assistance from contractor staff and Office of the General Counsel staff as necessary) whether any deviations significantly reduce the likelihood that the NRC will have ready access to adequate funding for decommissioning and/or site control and maintenance. The staff will complete the applicable "terms and conditions checklist" in Appendix F as an aid in determining whether appropriate provisions are included in the text of the mechanism.

3.3 Specific Guidelines for Insurance Policies and Special Arrangements with a Government Entity

NOTE: ***As stated above, all insurance policies and special arrangements with a government entity should be forwarded to DCB for review via a TAR (although Regions may also conduct their own separate reviews). This section outlines the procedures for review of the submittal by DCB staff.***

11. DCB staff will verify that all of the necessary items (as identified in Section 15.3.3 above) have been included in the submission. If any necessary items are not included, the staff will obtain the missing items from the licensee. (Note: At the staff's discretion, the request for the missing items may be postponed until other deficiencies, if any, have been identified.)

12. DCB staff will complete the applicable "terms and conditions checklist" in Appendix F to this SRP to determine whether the submitted mechanism includes the appropriate provisions. The submitted mechanism is acceptable if it includes all of the necessary provisions. For all deviations from the checklist or additional provisions contained in the mechanism, the staff will determine (with assistance from contractor staff and Office of the General Counsel staff as necessary) whether the deviations or provisions reduce the mechanism's protections in ensuring that NRC will have ready access to adequate funding for decommissioning and/or site control and maintenance.

3.4 Specific Guidelines for All Other Financial Assurance Mechanisms

13. The license reviewer or licensing project manager will compare the wording of the mechanism (including all attachments) to the recommended wording contained in

Appendix F to this SRP. The submitted wording is acceptable if it is identical to the recommended wording. If there are only minor differences in the wording, the Region may forward the mechanism to its Regional Counsel for review. In all other cases, the license reviewer or licensing project manager will forward the submittal to DCB for review as a “non-standard” submittal via a TAR.

For all deviations from the recommended wording, the reviewer will determine (with assistance from contractor staff, OGC staff, and/or Regional Counsel staff as necessary) whether any deviations significantly reduce the mechanism’s protections in ensuring that the NRC will have ready access to adequate funding for decommissioning and/or site control and maintenance. The reviewer will complete the applicable “terms and conditions checklist” in Appendix F as an aid in determining whether appropriate provisions are included in the text of the mechanism.

14. The reviewer will verify that all of the necessary items (as identified in Section 15.3.3 above) have been included in the submission. If any necessary items are not included with a standard submittal, or if any necessary items are not included with a non-standard submittal, the reviewer will obtain the missing items from the licensee. (Note: At the reviewer’s discretion, the request for the missing items may be postponed until other deficiencies, if any, have been identified.) However, if the submission contains additional items that are not listed above but that might affect the workings of the mechanism, the license reviewer or licensing project manager will forward the submittal to DCB for review as a non-standard submittal via a TAR.

APPENDIX H

SAMPLE POST-REVIEW LETTER FROM NRC TO LICENSEES

APPENDIX H
SAMPLE POST-REVIEW LETTER FROM NRC TO LICENSEES
(No Deficiencies in Submittal)

(**NOTE**: *Letter should be printed on NRC letterhead paper*.)

[Date (or date stamp)]

[Name of licensee representative]
[Title]
[Name of licensee]
[Address]

Dear [insert "Dr.," "Mr.," or "Ms."] [insert last name of licensee representative]:

We have reviewed your [insert description of information submitted by the licensee (e.g., decommissioning funding plan, certification of financial assurance, cost estimate, financial assurance mechanism)] dated [insert date]. Based on our review, we have no further comments at this time.

If you have any questions, you may contact us at [insert telephone number].

Sincerely,

[Name of NRC representative]
[Branch]

License No. [insert all applicable NRC license numbers]
Docket No. [insert all applicable NRC docket numbers]

APPENDIX I

OVERVIEW OF THE RESTRICTED USE AND ALTERNATE CRITERIA PROVISIONS OF 10 CFR PART 20 SUBPART E

OVERVIEW OF THE RESTRICTED USE AND ALTERNATE CRITERIA PROVISIONS OF 10 CFR 20 SUBPART E

Introduction

The requirements of 10 CFR 20.1403 and 10 CFR 20.1404 are briefly summarized in this overview. This overview is being included in this Standard Review Plan (SRP) to provide the staff with an understanding of the philosophy and approach used by the Commission in promulgating these provisions of 10 CFR Part 20 Subpart E. Staff should refer to the appropriate sections of the SRP to evaluate license requests for license termination under these provisions. In addition, Appendix J contains guidance on seeking public advice on institutional controls which should be used to evaluate a licensee's or responsible parties' program for compliance with 10 CFR 20.1403(d)(1-2) and 10 CFR 20.1404 (a)(4).

Prior to the promulgation of the License Termination Rule (LTR) (62 FR30958) U.S. Nuclear Regulatory Commission (NRC) regulations did not contain a provision for releasing sites for other than unrestricted use. Experience with decommissioning facilities has indicated that for certain sites, achieving the unrestricted use criterion might not be appropriate because: (1) there may be net public or environmental harm in achieving unrestricted use; (2) expected future use of the site would likely preclude unrestricted use; or, (3) the cost of cleanup and waste disposal to achieve the unrestricted use criterion is excessive compared with achieving the same dose criterion by restricting the use of the site and eliminating exposure pathways.

Similarly, for certain difficult sites with unique decommissioning problems, 10 CFR 20.1404 includes a provision by which the NRC may terminate a license using alternative dose criteria. The NRC expects the use of alternative criteria to be confined to rare situations. This provision was included in 10 CFR 20.1404 because the NRC believed that it is preferable to codify provisions for these difficult sites in the rule rather than require licensees to seek an exemption process outside the rule.

The NRC still considers unrestricted use to be the preferable method to decommission licensed facilities and terminate radioactive materials licenses. However, in recognition that there may be a limited number of sites where license termination with restrictions may be appropriate, the NRC included provisions for terminating the licenses for these few sites in the LTR.

Restricted Use

License termination under restricted conditions will be permitted pursuant to 10 CFR 20.1403 if all the following requirements are met:

1. The licensee can demonstrate that further reductions in residual radioactivity necessary to release the site for unrestricted use: (1) would result in net public or environmental harm; or, (2) were not being made because the residual levels are ALARA (10 CFR 20.1403(a)).

2. The licensee has made provisions for legally enforceable institutional controls that would limit dose to the average member of the critical group to 0.25 milliSieverts per year (0.25 mSv/yr)(25 millirem/year (25 mrem/yr)(10 CFR 20.1403(b)).

3. The licensee has provided sufficient financial assurance to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site (10 CFR 20.1403(c)).

4. The licensee has submitted a decommissioning plan or a license termination plan to the NRC that indicates the licensee's intent to release the site under restricted conditions and describes how advice from individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice (10 CFR 20.1403(d)). In seeking this advice, the licensee would have conducted the activities for seeking advice required by 10 CFR 20.1403(d)(2), including providing for participation by a broad cross-section of community interests who may be affected by decommissioning; providing an opportunity for a comprehensive collective discussion of the institutional controls and financial assurance specified in 10 CFR 20.1403(d)(1) by the affected parties; and providing a publicly available summary of all such discussions.

5. The residual radioactivity levels have been reduced so that, if the institutional controls were no longer in effect, the annual dose to the average member of the critical group would not exceed either 1 mSv/yr (100 mrem/yr) or, under certain conditions, 5mSv/yr (500 mrem/yr). If the 5 mSv/yr value is used, the licensee must: (1) demonstrate that achieving 1 mSv/yr is prohibitively expensive, not technically achievable, or would result in net harm, (2) make provisions for durable institutional controls, and (3) provide sufficient financial assurance to allow an independent third party to carry out rechecks of the controls and maintenance at least every 5 years and carry out any necessary controls and maintenance (10 CFR 20.1403(e)).

The NRC staff will review and evaluate the decommissioning plan and will solicit public input to determine whether the above requirements are satisfied, pursuant to 10 CFR 20.1405. Once the NRC determines that they have been met, the NRC license is terminated and the NRC no longer regulates or oversees the site, except in the circumstances indicated in 10 CFR 20.1401(c). Specifically, 10 CFR 20.1401(c) indicates that the NRC could require additional cleanup after license termination if it determines that, based on new information, the criteria in Subpart E of 10 CFR Part 20 for release of a site were not met <u>and</u> residual radioactivity remaining at the site could result in a significant threat to public health and safety. Please note that the Commission has explictly chosen not to define what constitutes "new information" or "significant public risk," because this determination will be made on a case-by-case basis. Also note that there is some potential that a license termination could be revisited as a result of a future Environmental Protection Agency (EPA) rulemaking.

In some instances a licensee planning license termination with restricted conditions under an approved decommissioning plan or license termination plan may find, during remediation, that the site can be cleaned up to a level that would not require restricted conditions. Additionally, a licensee that had planned unrestricted release may find during remediation that unrestricted release is not practical. In these instances, the licensee should submit an amended decommissioning plan or license termination plan to NRC as soon as possible.

The restricted conditions should be limited to the smallest portion of the site that is appropriate. However, all areas that will be subject to restricted conditions should be contained within one or occasionally two areas. Complicated checkerboard patterns of areas with restricted conditions should be avoided.

Alternate Criteria

Under 10 CFR 20.1404, the NRC may consider terminating a license using alternate criteria that are greater than 0.25 mSv/yr (25 mrem/yr) with restrictions in place found at 10 CFR 20.1403. However, licensees requesting license termination under the alternate criteria provisions of 10 CFR 20.1404 would still need to ensure that potential doses from residual radioactivity are less than 1 mSv/yr (100 mrem/yr) with restrictions in place. In addition, the NRC will limit the conditions under which a licensee could apply to the NRC for, or be granted use of, alternative criteria to unusual site-specific circumstances subject to the following provisions:

1. The licensee has provided assurance that public health and safety will continue to be protected and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than 1 mSv (100 millirems) per year. A licensee proposing to use alternative criteria would have to provide a complete and comprehensive analysis of such possible sources of exposure;

2. The licensee has employed, to the extent practical, restrictions on site use for minimizing exposure at the site, using the provisions for institutional controls and financial assurance in 10 CFR 20.1403;

3. The licensee has reduced doses to ALARA levels, based on a comprehensive analysis of risks and benefits of all viable alternatives;

4. The licensee has sought advice from affected parties regarding the use of alternative criteria at the site. In seeking this advice, the licensee would have conducted the activities for seeking advice required by 10 CFR 20.1404(a)(4), including providing for participation by a broad cross-section of community interests that may be affected by decommissioning; providing an opportunity for a comprehensive collective discussion of the issues related to the alternative criteria by the affected parties; and providing a publicly available summary of all such discussions[1]. As part of this process, the licensee would submit a decommissioning plan indicating how advice of individuals and institutions in the community that may be affected by the decommissioning has been sought and addressed;

[1] 10 CFR 20.1403 requires that licensees or responsible parties obtain advice from institutions and individuals that may be affected by the decommissioning on specific issues related to institutional controls and financial assurance. However, 10 CFR 20.1404 provides for a much broader discussion of the issues associated with the use of alternate criteria and, as such, licensees must obtain advice on essentially any issue associated with the use of alternate criteria.

5. The licensee has obtained the specific approval of the Commission for the use of alternative criteria. The Commission will make its decision after considering the NRC staff's recommendations that would address any comments provided by the EPA and any public comments submitted regarding the decommissioning plan pursuant to 10 CFR 20.1405.

Institutional Controls

Institutional controls are used to ensure that the exposure from the residual radioactivity does not exceed the criteria in 10 CFR 20.1403 or 1404. Institutional controls include measures to control access to the site and minimize disturbances to engineered measures established by the licensee to control the residual radioactivity. Institutional controls include administrative mechanisms (e.g., land use restrictions) and may include, but not be limited to, physical controls (e.g., signs, markers, landscaping, and fences). As discussed below, they must be legally enforceable and the entity charged with their enforcement must have the capability, authority, and willingness to enforce the institutional controls. If the institutional control includes physical controls, they must include measures to monitor their performance and to provide for their maintenance or replacement along with sufficient financial assurance to provide for the necessary monitoring, maintenance or replacement. Generally, engineered measures should be designed to last, without the need for replacement and with minimum maintenance, over the time period established for the institutional controls.

Institutional controls address a variety of restrictions and need to be tailored to each site situation. Restrictions may include prohibitions on farming, industrial, recreational, or residential use. Prohibitions on excavation and water use may also be warranted. Institutional controls are usually characterized as "proprietary" or "governmental." Generally, a layering of different restrictions and mechanisms are needed to provide for durable and effective institutional controls.

Institutional controls based on property rights involve a party that owns rights that restrict the use of, or access to, the property and are referred to as "proprietary institutional controls." Institutional controls based on property rights apply to land owned by individuals or private institutions and land owned by governments.

Institutional controls that involve a government using its sovereign or police powers to impose restrictions on citizens or sites under its jurisdiction to limit the use and occupation of privately owned lands are referred to as "governmental institutional controls." Among the more common governmental institutional controls are zoning, well-use restrictions, and building permit requirements.

Zoning is a legal designation placed on land by a local government that restricts the types of uses on a particular property. Overlay zoning consists of zones drawn on a municipality's existing zoning map that provides protection not explicitly stated under existing zoning requirements. Since zoning is subject to change, zoning generally should be used in combination with other restrictions.

Governments, most often local, can place restrictions on private property prohibiting or limiting use. Such government-imposed restrictions could include prohibiting construction of wells for water use, restricting the use of other potential water supplies, issuing permits for certain activities including use of wells for drinking water or construction or use of buildings, and establishing county or State ordinances and property law regulations.

At some sites institutional controls may include physical controls (e.g., fences, markers, earthen covers, radiological monitoring, and the maintenance of those controls). Physical controls alone do not meet the requirement in 10 CFR 20.1403(b) for legally enforceable institutional controls because they lack a mechanism for legal enforcement. Physical controls and their maintenance can be used to meet the requirement in 10 CFR 20.1403(b) only when they are used in combination with an instrument that permits legal enforcement of the physical control.

In addition to requiring that the institutional controls function to limit the dose to 0.25 mSv/y (25 mrem/yr) in 10 CFR 20.1403(b), Subpart E also contains (in 10 CFR 20.1403(e)) two levels of protection based on potential exposure if the institutional controls become ineffective. Based on those two levels, the institutional controls and the parties enforcing the controls need to meet the following criteria:

1. If the annual dose to the average member of the critical group would not exceed 1 mSv/yr (100 mrem/yr) if the institutional controls were no longer in effect, a private individual, organization, or Federal, State or local government may be acceptable as the entity responsible for enforcing the institutional control[2] depending on the circumstances at the site; or

2. If the annual dose could exceed 1 mSv/yr (100 mrem/yr) but be less than 5 mSv/yr (500 mrem), if the institutional controls were no longer in effect, 10 CFR 20.1403(e) requires that a more durable institutional control be used. To meet the requirement in 10 CFR 20.1403(e), an institutional control that involves government ownership of land would be generally acceptable. On privately owned land, a Federal, State or local government as the entity responsible for enforcing the restriction could also be acceptable, depending on the circumstances at the site.

Finally, restrictions will need to remain in place for the duration that they are needed, up to 1000 years. The duration may be a definite specified duration or an indefinite duration. Definite durations are for a specified number of years (for example, the number of years until radiological decay or other processes have reduced the concentration to a level corresponding to an annual dose to the average member of the critical group of less than 0. 25 mSv/yr (25 mrem/yr) without the restrictions). Indefinite durations might end when some measurable event

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[2] The Commission has stated (see Section B3.3 of the Statements of Consideration for 10 CFR Part 20,Subpart E “Radiological Criteria for License Termination”) that stringent institutional controls would be needed for sites involving large quantities of uranium and thorium contamination. Typically these would involve legally enforceable deed restrictions backed up by State and local government control or ownership, engineered barriers, and as appropriate, Federal ownership

has occurred (for example, when natural processes have adequately reduced the risk of exposure to the residual radioactivity).

The NRC staff will review and evaluate the decommissioning plan and will solicit public input to determine whether the above requirements are satisfied, pursuant to 10 CFR 20.1405.

APPENDIX J

EVALUATING LICENSEE EFFORTS TO OBTAIN PUBLIC ADVICE ON INSTITUTIONAL CONTROLS

Evaluating Licensee Efforts to Obtain Public Advice on Institutional Controls

Subpart E of 10 CFR Part 20 requires that public input on the institutional controls proposed by the licensee be sought during the decommissioning process. Licensees, as part of their planning for restricted use, are required by 10 CFR 20.1403(d) to seek advice from individuals and institutions in the community that may be affected by the decommissioning. The rationale for this requirement (as stated in Reference 9) is that the licensee's direct involvement regarding diverse community concerns and interests can be useful in developing effective institutional controls, and this information should be considered and incorporated as appropriate into the decommissioning plan or License Termination Plan (LTP) before it is submitted to the U.S. Nuclear Regulatory Commission (NRC) for review. This appendix provides guidance on complying with 10 CFR 20.1403(d).

Once the decommissioning plan or LTP is submitted to the NRC, the NRC reviews the licensee's plans for license termination, including the institutional controls proposed to restrict site use. As part of NRC's review process, under 10 CFR 20.1405, the NRC must notify and solicit comments from the public regarding the proposed licensee action. Significant and appropriate public involvement in NRC's review process will take place at this time. Because it is the NRC's, not the licensee's, responsibility to carry out this action, this appendix does not provide guidance to licensees in this area.

To comply with 10 CFR 20.1403(d), and to ensure that the fundamental performance objectives of institutional controls are met, licensees who plan to release a site under restricted conditions must:

- Seek advice on whether the provisions for institutional controls will (1) provide reasonable assurance that annual doses will not exceed 0.25 milliSieverts per year (0.25 mSv/yr) (25 millirem per year (25 mrem/yr), (2) be enforceable, and (3) not impose undue burdens on the community;

- Seek advice from representatives of a broad cross-section of individuals and institutions in the community that may be affected by the decommissioning (affected parties);

- Provide an opportunity for a comprehensive, collective discussion on the issues;

- Provide a publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

- Describe, in the decommissioning plan or LTP, how advice from the affected parties has been sought and incorporated, as appropriate, following analysis of that advice.

As required by 10 CFR 20.1403(d)(1), the advice to be sought is whether the institutional controls proposed by the licensee will:

- Provide reasonable assurance that the total effective dose equivalent from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 0.25 mSv/yr (25 mrem/yr);

- Be enforceable;

- Not impose undue burdens on the local community or other affected parties; and

- Be backed by sufficient financial assurance for any necessary control and maintenance of the site by an independent third party.

The licensee should first identify the affected parties. According to 10 CFR 20.1403(d)(2), the licensee must provide for participation by representatives of a broad cross-section of community interests who may be affected by the decommissioning. Affected parties may include:

- Any State, local, or Federal government agency, other than the NRC, that has jurisdiction or responsibilities with respect to the site to be decommissioned;

- Local community, civic, labor, or environmental organizations with an interest in the decommissioning, and whose members would be affected by the decommissioning;

- Adjacent landowners whose properties abut the site or portions of the site to be released under restricted conditions; and/or

- Any Indian tribe or other indigenous people who have relevant treaty or statutory rights that may be affected by the decommissioning of the site.

The licensee should establish a method for seeking advice, from the affected parties, on the adequacy of the institutional controls and the sufficiency of financial assurance. It is desirable for the licensee to meet with the NRC staff to describe its intended methods for seeking advice from affected parties prior to beginning this activity in order to ensure that the proposed method will be acceptable to the NRC staff.

In obtaining input from affected parties, licensees should convene a site-specific advisory board (SSAB) (i.e., a group representing a broad cross-section of the community that may be affected by the decommissioning). If creation of an SSAB is not appropriate for a particular situation, the licensee may consider satisfying the requirements of 10 CFR 20.1403 by seeking advice directly from the affected parties, without the use of an SSAB.

In general, the NRC considers that convening an SSAB should be the starting point in providing for public involvement because an SSAB is the most effective way to ensure that the licensee considers the diversity of views in the community. Small group discussions can be a more effective mechanism than written comments or large public meetings for articulating the exact nature of community concerns, determining how much agreement or disagreement there is on a particular issue, and facilitating the development of acceptable solutions to issues. Also, the type of close interaction resulting from a small group discussion could help in developing a credible relationship with the community in which it is operating.

It is important to note that the SSAB does not have to be a new group formed specifically for the decommissioning. Any group that can perform the functions of an SSAB may be considered to be an SSAB. Thus, if an existing or established group in the community has enough participation by the affected parties and can effectively perform the functions of the SSAB, that group may be used by the licensee as the SSAB.

The use of an SSAB may not be appropriate in all situations, for example, if a broad cross-section of the community clearly has insufficient interest or wishes to defer its involvement to a State or local governing body. If the licensee does not plan to convene an SSAB, it is desirable for the licensee to meet with the NRC staff to justify why an SSAB is not being convened and to describe its intended method for obtaining public input to satisfy the performance objectives. Such a meeting should take place prior to beginning this effort in order to ensure the proposed method will be acceptable to the NRC.

Licensees should use the following guidance in establishing and convening an SSAB:

- The licensee should solicit members to serve on the SSAB. Membership should reflect the full range of the affected parties' interests by selecting representatives from the affected parties to present the views of the organization or interest that they represent. Government agencies and other organizations should be able to nominate their own representatives to the SSAB. Invited participants should be informed of the objectives of the SSAB. The SSAB normally consists of about 8 to 10 members;

- Members of the SSAB should agree to meet their responsibilities as a condition of membership. In general, NRC regulations require that the decommissioning plan be submitted within 12 months after notifying the NRC that the site will be decommissioned. The licensee is responsible for meeting this requirement. Therefore, the licensee is responsible for ensuring that the SSAB is meeting a schedule that will allow the licensee to submit the plan within the required time. If the board does not meet its responsibilities, the licensee should evaluate and discuss with the SSAB any problem and how to resolve it;

- The SSAB members should be selected as soon as practical after the licensee notifies the NRC of its intention to decommission and terminate the license;

- The licensee should provide reasonable administrative support for SSAB activities and access to licensee studies and analyses that are pertinent to the proposed decommissioning;

- To avoid the appearance of a conflict of interest, members of the SSAB usually are not paid by the licensee. However, reimbursement for expenses incurred is acceptable;

- The licensee should establish a schedule for the work of the SSAB that allows the licensee to obtain advice from the SSAB, incorporate the advice into the decommissioning plan or LTP as appropriate, and submit the decommissioning plan or LTP within the time required by NRC regulations. The schedule should include submittal of the SSAB's advice, allowing sufficient time for the licensee to analyze the advice and describe in the decommissioning plan or LTP how the advice was incorporated, as appropriate;

- The licensee should propose a charter and operating procedures for the SSAB's consideration. The charter and operating procedures should address the advice to be sought and the characteristics of an SSAB;

- The SSAB should: (1) select a chairperson, (2) adopt a charter and operating procedures, (3) work with the licensee to identify and obtain information needed in its evaluation process, (4) hold meetings open to the public, provide for a comprehensive, collective discussion of the issues, and allow the opportunity for public comment at the meetings, (5) respond to concerns and questions raised by the public, making the results publicly available, (6) provide advice to the licensee on the topics listed above and on any other topics the licensee wants discussed, (7) to the extent feasible, abide by the schedule established by the licensee to meet NRC requirements, and (8) ensure that a publicly available summary of the results of all discussions, including descriptions of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues, is developed to support the meeting;

- SSAB meetings should be open to the public with adequate public notice (at least two weeks in advance) of the location, time, date, and agenda for the meetings. Consideration should be given to print, electronic, and web site notification methods. The licensee should inform the NRC of SSAB meetings and distribution of information made at SSAB meetings because these meetings and distributions may cause the public to contact the NRC; and

- A summary of the results of all collective discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues, should be made publicly available.

If a licensee determines that an SSAB is not appropriate or feasible and an SSAB is not convened, the licensee is still required by 10 CFR 20.1403(d) to seek advice from representatives of a broad cross-section of community interests, including governmental institutions with jurisdiction and responsibilities, that may be affected by the decommissioning (i.e., affected parties). The licensee must also conduct a comprehensive collective discussion of the issues. The method used for interacting directly with the public and seeking such public advice should have the following characteristics:

1. The affected parties should be informed of the decommissioning and informed that their advice is being sought. The methods and efforts that can be used initially to inform the public can include, as appropriate for the specific site:

   - Information in mass media, for example, articles, advertisements, and public service announcements in newspapers, television, and radio;
   - Web sites or other related technologies;
   - Flyers distributed in the neighborhood or mailings to individual residents close to the site;
   - Letters or telephone contacts with government agencies and local community, civic, and labor organizations; or,
   - Presentations at public meetings.

2. The licensee should clearly state, to the affected parties, the matters on which advice is being sought with sufficient clarity to obtain meaningful input.

3. The initial information provided to interested affected parties should describe the decommissioning process, characterize in basic terms the nature and extent of residual radioactivity at the site, and provide pertinent information about the licensee's request for license termination under restricted conditions. Information should be provided early enough to allow sufficient time for review by the affected parties. The initial information and any subsequent long, complex studies should be provided at least 30 days before the meeting. Although there should be as much time provided as practical, it is acceptable for short simple supplemental information to be provided with very little time for review.

4. The licensee should establish a method for receiving advice from the affected parties. There should always be a method to receive written comments. The licensee should also hold public meetings to obtain oral comments. There may also be a method to obtain comments electronically, such as by e-mail or through a web site. Comments received should be available for public inspection.

5. The licensee should hold at least three public meetings for discussion of the issues. The licensee should inform the NRC of public meetings and the information distributed at the meetings, because these meetings and distributions may cause the public to contact the NRC.

6. A summary of the results of all collective discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues, is to be made publicly available.