Fusion Systems Rulemaking

NOTE: The Nuclear Regulatory Commission (NRC) is making a select portion of the preliminary draft guidance available to the public solely for the purpose of providing information to the public and to provide preparatory material for upcoming public meetings. This language does not represent a final NRC staff position, nor has it been reviewed by NRC management. Therefore, the preliminary draft guidance may undergo significant revision during the rulemaking process. The NRC is not requesting public comments on this preliminary draft guidance, and no stakeholder requests for a comment period will be granted at this stage in the rulemaking process. Following Commission direction to proceed with the proposed rule, the NRC will seek public comment on the proposed rule along with the draft guidance in the Federal Register.

Preliminary Draft NUREG-1556, Volume 22
Consolidated Guidance About Materials Licenses
Program-Specific Guidance About Fusion System Licenses

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 ADAMS Accession No. ML23355A143

8.5.3 Financial Assurance and Recordkeeping for Decommissioning

Regulations: 10 CFR 20.2108; 10 CFR 30.34(b), 10 CFR 30.35, 10 CFR 30.51(f)

Criteria: A licensee authorized to possess radioactive material in excess of the limits specified in 10 CFR 30.35 must submit a decommissioning funding plan (DFP) or provide a certification of FA for decommissioning. It is expected that a fusion system licensee will need to prepare a DFP due to the quantities of tritium and activation products possessed. Even if a DFP or certification of FA is not required, licensees are required under 10 CFR 30.35(g) to maintain, in an identified location until the site is released for unrestricted use, decommissioning records related to leaking sources and structures, equipment, and the site where radioactive materials are used or stored. Also, before licensed activities are transferred or assigned in accordance with 10 CFR 30.34(b), licensees must transfer records important to decommissioning to the proposed new licensee in accordance with 10 CFR 30.35(g). Furthermore, before a license is terminated, the licensee must send records important to decommissioning that are required by 10 CFR 30.35(g) to the appropriate NRC regional office in accordance with 10 CFR 30.51(f).

Discussion: The NRC seeks to ensure that decommissioning will be carried out with minimum impact on public and occupational health and safety and the environment. Most fusion system facilities that produce radioactive materials will be required to comply with the FA requirements because of the tritium and incidentally-activated materials produced during operations. NRC regulations requiring a DFP or FA are designed to provide reasonable assurance that the decommissioning of 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 in accordance with 10 CFR 30.35. These requirements, if applicable, specify that a licensee either set aside funds for decommissioning activities or provide a guarantee, through a third party, that funds will be available to decommission and release the site for unrestricted use. Applicants are required to submit a DFP or provide FA when they possess radioactive material with a half-life greater than 120 days that exceeds certain limits. Regulations in 10 CFR 30.35 set forth criteria for determining if an applicant is required to submit a DFP or has the option of submitting either a DFP or a certification of FA.

A DFP contains a site-specific cost estimate and a certification by the licensee that it has provided FA in the amount of the cost estimate for decommissioning prior to the issuance of the license. The DFP must also contain a signed original of this financial instrument, which must satisfy the requirements of 10 CFR 30.35(f). Subsection (f) establishes the methods by which any FA instrument, such as a prepayment, surety bond, insurance, or sinking fund, must be provided. As an alternative to developing a DFP, some licensees may be eligible under 10 CFR 30.35(b)(2) to submit a certification of FA in an amount corresponding to the table of possession limits set forth in 10 CFR 30.35(d). Note that a certification of FA instrument must meet the same 10 CFR 30.35(f) requirements as a DFP.

NUREG–1757, Vol. 3, “Consolidated Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness,” provides guidance acceptable to NRC staff on the information to be provided for establishing FA for decommissioning and a standard format for presenting the information. (See Figure X-X for some acceptable forms of FA.)

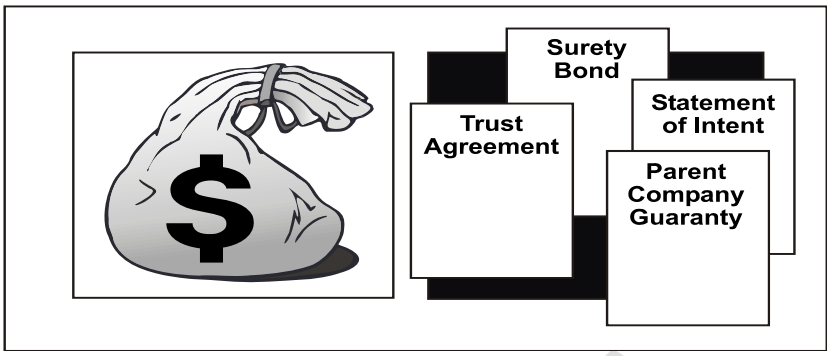

Figure X-X. Financial Assurance for Decommissioning

The requirements for maintaining records important to decommissioning, including the type of information required, are stated in 10 CFR 30.35(g). These requirements also apply to licensees that are not required to submit a DFP or certification of FA. Under this provision, "records important to decommissioning" include:

(1) Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of tritium migration into fusion system components and structural materials such as concrete. These records must include any known information identifying involved nuclides, quantities, forms, and concentrations.

(2) As-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used and stored, and of locations of possible inaccessible contamination, such as buried pipes, that may be subject to contamination. If drawings are not available, the licensee must substitute appropriate records of available information concerning these areas and locations.

(3) Except for areas containing only sealed sources (provided the sources have not leaked, or no contamination remains after any leak) or byproduct materials having only half-lives of less than 65 days, a list contained in a single document and updated every 2 years, of the following:

  (i) all areas designated and formerly designated restricted areas as defined in 10 CFR 20.1003, "Definitions."

  (ii) all areas outside of restricted areas that require documentation under 10 CFR 30.35(g)(1)

  (iii) all areas outside of restricted areas where current and previous wastes have been buried as documented under 10 CFR 20.2108

  (iv) all areas outside of restricted areas that contain material such that, if the license expired, the licensee would be required to either decontaminate the area to meet the criteria for decommissioning in 10 CFR Part 20 (Subpart E), "Radiological Criteria for License Termination," or apply for approval for disposal under 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures"

(4) Records of the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning, and records of the funding method used for assuring funds if either a funding plan or certification is used.

It is also important to note that under 10 CFR 30.35(e)(2), the DFP must be updated at the time of license renewal and at intervals not to exceed 3 years, to account for changes in costs and the extent of contamination. The updated DFP must also specifically consider the decommissioning cost impacts of:

(i) spills of radioactive material producing additional residual radioactivity in onsite subsurface material

(ii) waste inventory increasing above the amount previously estimated

(iii) waste disposal costs increasing above the amount previously estimated

(iv) facility modifications

(v) changes in authorized possession limits

(vi) actual remediation costs that exceed the previous cost estimate

(vii) onsite disposal

The regulations in 10 CFR 30.35(g) also require that licensees maintain records important to decommissioning in an identified location until the site is released for unrestricted use. In accordance with 10 CFR 30.35(g), licensees must transfer records important to decommissioning to any new proposed licensee before licensed activities can be transferred or assigned according to 10 CFR 30.34(b). Furthermore, under 10 CFR 30.51(f), before license termination, each licensee will forward the records required by 10 CFR 30.35(g) to the appropriate regional office. Recipients of existing licenses in accordance with 10 CFR 30.34(b) are also responsible for maintaining these records until the license is terminated or transferred to another party. Careful recordkeeping of radionuclides possessed and used, including their form, amount, and the size of the area(s) where they have been used, will facilitate license termination and release of the area(s) for unrestricted use.

Response from Applicants:

- State the following: "Pursuant to 10 CFR 30.35(g), we will maintain records important to decommissioning and transfer these records to an NRC or Agreement State licensee before licensed activities are transferred or assigned in accordance with 10 CFR 30.34(b). Furthermore, pursuant to 10 CFR 30.51(f), prior to license termination, we will forward the records required by 10 CFR 30.35(g) to the appropriate NRC regional office or assign the records to the appropriate NRC regional office before the license is terminated."

  AND

- **If financial assurance is required**, submit a DFP and evidence of financial assurance following the guidance of NUREG–1757, Volume 3.

Reference: NUREG–1757, Volume 3, "Consolidated Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness."

8.7 Item 7: Individual(s) Responsible for Radiation Safety Program and Their Training and Experience

8.7.1 Radiation Safety Officer

Regulations: 10 CFR 30.32(k), 10 CFR 30.33.

Criteria: The Radiation Safety Officer's (RSO's) training and experience should be applicable to and generally consistent with the types and quantities of licensed material listed on the license for which the individual's authorization as an RSO is requested.

Discussion: The person responsible for the radiation protection program is the RSO. The RSO is key to overseeing and ensuring safe operation of the licensee's radiation protection program. The RSO must have adequate training to understand the hazards associated with radioactive material and be familiar with all applicable regulatory requirements. The RSO shall have independent authority to stop operations considered to be unsafe. The RSO should have sufficient time and commitment from management to fulfill the duties and responsibilities of the position to ensure that (i) radioactive materials are used in a safe manner; (ii) approved radiation safety procedures are being implemented; and (iii) the required records of licensed activities are maintained. This management support includes resource allocation.

Typical RSO duties are illustrated in Figure X-X and described in Appendix X of this NUREG. The NRC requires the name of the RSO to be listed on the license to ensure that licensee management always has a responsible, qualified person identified and that the named individual knows they have been designated as RSO.

Appendix X of this NUREG also provides a model Delegation of Authority, which should be used to further emphasize the agreement on duties and responsibilities of the RSO by management and the designated RSO.

The RSO may delegate certain day-to-day tasks of the radiation protection program to other responsible individuals (designees). Licensees may also appoint alternate RSOs (ARSO) who may "step in" as the point of contact when the RSO is unavailable. Such designees or ARSOs do not need to meet all RSO qualifications, but these individuals should be qualified, experienced authorized users who have adequate knowledge of the activities to which they are assigned. These individuals are typically AUs (see following section). Designees and ARSOs should have the same management support and decision-making authority as the RSO necessary to accomplish the tasks to which they have been assigned, but they are not required to have a delegation of authority from management.

Please note that only the primary RSO is named on an NRC license.

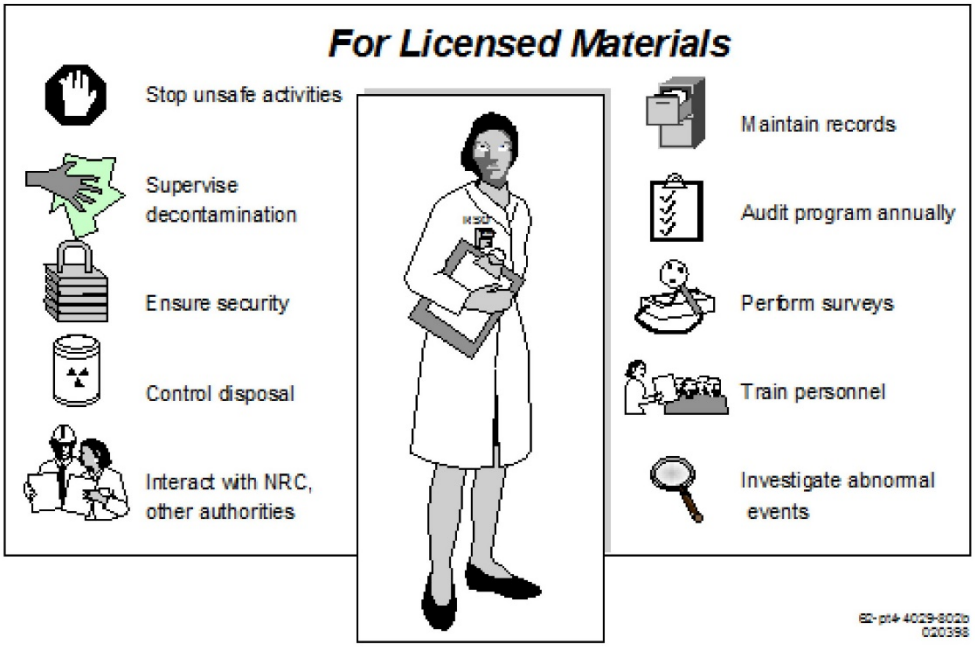

Figure X-X Typical Duties and Responsibilities of RSOs.

The RSO should have at a minimum, (i) a college degree at the bachelor's level or equivalent training and experience in physical, chemical, biological sciences, or engineering; and (ii) training and experience commensurate with the scope of proposed activities.
Training should include the following subjects:

- radiation protection principles
- characteristics of ionizing radiation
- units of radiation dose and quantities
- radiation detection and measurement instrumentation
- biological hazards of exposure to radiation (appropriate to types and forms of byproduct material to be used)
- NRC regulatory requirements and standards commensurate with the uses proposed by the applicant
- handling of radioactive materials in relation to fusion system activities (e.g., tritium handling)
- Security of radioactive materials

Experience should include the following areas:

- planning and conducting evaluations, surveys, and measurements similar to those that the licensee's radiation safety program requires
- use of licensed materials similar in types, forms, and quantities to those proposed for use under the license

- security and control of licensed materials
- storage, handling, disposal, and documentation of radioactive waste materials
- monitoring inventory and accountability of materials possessed under the license, maintaining records of receipts, transfers, and disposal of licensed materials
- effluent and environmental monitoring, including tritium
- planning, conducting, and documenting audits and other evaluations of the radiation safety program
- evaluation and documentation of radiation exposures
- maintaining required records of the radiation safety program and providing required reports
- other applicable duties and responsibilities, as described in Appendix X of this NUREG

The amount of training and experience will depend on the type, form, quantity, and proposed use of the licensed material requested. For instance, in addition to a college degree, RSOs at fusion system facilities may need at least 40 hours of radiation safety training specific to their job duties, as well as a year of experience with similar types, forms, quantities, and uses of radioactive material before the individual is qualified to be an RSO. The RSO designee should have obtained the above training in formal course(s) designed for RSOs, presented by an academic institution, commercial radiation safety consulting company, or a professional organization of radiation protection experts. In addition, the proposed RSO's experience should be sufficient to identify and control the anticipated radiation hazards. For example, the RSO should have experience planning and conducting evaluations, surveys, and measurements similar to those required by the licensee's radiation safety program.

Response from Applicant: Provide the following:

- name of the proposed RSO
- information demonstrating that the proposed RSO is qualified by training and experience; information should include, as a minimum
    - formal training or education in radiation safety [topics covered, duration of training, when training was received, identity and location of training provider (note: a course outline may be provided)]
    - experience using licensed materials (types, forms, quantities handled, activities performed, duration of experience)
    - experience performing the duties of an RSO (activities, duration of experience, scope of program)

Notes: Applicants should provide information about the proposed RSO's training and experience with the licensed material and uses requested in the application. Do not include private, personal information (e.g., home address, home telephone number, Social Security number, date of birth, and radiation dose information). Applicants should not submit extraneous information, such as unrelated lists of publications, research grants, committee and society memberships, and personal private information. Submittal of unrelated material may delay the review process.

Notify the NRC and obtain a license amendment before making changes in the designation of the RSO listed on the license.

8.7.2 Individuals Authorized to Handle Licensed Material

Regulations: 10 CFR 20.1101, 10 CFR 30.32(k), 10 CFR 30.33

Criteria: Authorized users (AU) must have adequate training and experience with the types and quantities of licensed material they propose to use.

Discussion: Applicants must name at least one individual who is qualified to handle the requested materials (i.e., AU). An AU is an individual whose training and experience have been reviewed and approved by the NRC, who is named on the license, and who uses or directly supervises the use of licensed material. The AU's primary responsibility is to ensure that radioactive materials are used safely and according to regulatory requirements. The AU is also responsible for ensuring that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA.

AUs must have adequate and appropriate training and experience to provide reasonable assurance that they will use licensed material safely. To demonstrate adequate training and experience, an AU should have (i) a college degree at the bachelor's level or equivalent training and experience in physical, chemical, biological sciences, or engineering; and (ii) training and experience commensurate with the scope of proposed activities. Training should include the following subjects:

- radiation protection principles
- characteristics of ionizing radiation
- units of radiation dose and quantities
- radiation detection instrumentation
- biological hazards of exposure to radiation (appropriate to the types and forms of byproduct material to be used)
- handling and using of radioactive materials relevant to the fusion system being licensed

The amount of training and experience needed will depend upon the type, form, quantity, and proposed use of the licensed material requested, but it should cover the subjects stated.

- Material control and security
- Response to emergencies or accidents

In general, AUs should demonstrate training and experience with the type and quantity of material they propose to handle. For example, an individual trained and experienced only with sealed radioactive sources might not be qualified to use or supervise the use of unsealed licensed material. In addition, someone using only trace quantities of a radioactive material may not understand the risks of working with quantities of radionuclides orders of magnitude larger.

Response from Applicant: Applicants should provide the following:

- name of each proposed AU with the types and quantities of licensed material to be used
- information demonstrating that each proposed AU is qualified by training and experience to use the requested licensed materials; information should include, as a minimum:
    - formal training or education in radiation safety [topics covered; duration of training; when training was received; identity and location of training provider (note: a course outline may be provided)]
    - experience using licensed materials (types; forms; quantities handled; activities performed; duration of experience)

Note: Applicants should provide information about the proposed AU's training and experience relative to the licensed material requested in the application. Applicants should not submit extraneous information, such as unrelated lists of publications, research grants, committee, and society memberships, etc. Submittal of unrelated material serves only to slow the review process.

8.10.12 Security Program

Regulations: 10 CFR 20.1801, 10 CFR 20.1802, 10 CFR 20.2201, 10 CFR Part 37

Criteria: Licensees must ensure the security of licensed material (10 CFR 20.1801 and 10 CFR 20.1802). Licensees must report any lost, stolen, or missing licensed material in an aggregate quantity exceeding specified limits (10 CFR 20.2201).

Discussion: Licensees must secure and control licensed material and should have a means of promptly detecting losses of licensed material. Regulations in 10 CFR 20.1801 and 20.1802 require licensees to secure radioactive materials from unauthorized removal or access while in storage in controlled and unrestricted areas and to control and maintain constant surveillance over licensed material that is in a controlled or unrestricted area and not in storage.

Security: To meet 10 CFR 20.1801, all licensed materials stored in controlled or unrestricted areas must be secured from unauthorized access or removal, so that individuals who are not knowledgeable about radioactive materials cannot be exposed to or contaminated by the material and cannot take the material. When any licensed material is used or handled in controlled or unrestricted areas, it must be under constant surveillance to prevent others from becoming contaminated by or exposed to the material, or to prevent persons from removing the material from the area. Acceptable methods for securing material will vary from one facility to another. Some alternatives used by licensees include: (i) storage and use of licensed materials only in restricted areas, (ii) limiting access to an entire facility or building or portion of the building only to radiation workers, (iii) providing storage areas that can be locked to prevent access to the material, and (iv) implementing procedures that require a radiation worker to be within “line of sight” of the materials whenever licensed materials are in use. Applicants should develop procedures that clearly state acceptable methods to secure licensed material at their facility. Particular attention may need to be paid to security procedures at facilities that may have unusual needs due to the activities performed.

<u>Requirements in 10 CFR Part 37, “Physical protection of category 1 and category 2 quantities of radioactive material”</u>

In accordance with 10 CFR Part 37, licensees that possess aggregated Category 1 or Category 2 quantities of radioactive material must establish, implement, and maintain an access authorization program (Subpart B) and a security program (Subpart C) to ensure physical protection of the radioactive material.

Table 1 of Appendix X, “Category 1 and Category 2 Radioactive Materials,” to 10 CFR Part 37, lists Category 1 and Category 2 threshold quantities of radioactive material. The applicant should refer to this table to determine whether its proposed activities would be subject to the 10 CFR Part 37 requirements.

Before giving individuals unescorted access to Category 1 or Category 2 quantities of radioactive material (as defined in 10 CFR 37.5), licensees must conduct background investigations of these individuals, to determine that they are trustworthy and reliable, in accordance with 10 CFR 37.25. In accordance with 10 CFR 37.41(b), licensees must establish a security program designed to monitor and, without delay, detect, assess, and respond to any actual or attempted unauthorized access to Category 1 or Category 2 quantities of radioactive material. Per 10 CFR Part 37, Subpart D, licensees must provide for physical protection of Category 1 or Category 2 quantities of radioactive materials in transit. These requirements apply

to licensees delivering such material to a carrier for transport, as well as cases in which licensees are transporting such material. Please note that the Subpart D requirements applicable to the transport of Category 1 quantities of radioactive material are more stringent than those applicable to Category 2 quantities.

For additional guidance on implementing 10 CFR Part 37 requirements, see NUREG–2155, “Implementation Guidance for 10 CFR Part 37, “Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material.”” Additional information regarding best practices for protection of risk-significant radioactive material is available in NUREG–2166, “Physical Security Best Practices for the Protection of Risk-Significant Radioactive Material.”

Cyber Security

When assessing the potential cybersecurity implications of Fusion energy systems being developed under 10 CFR Part 30, the licensee should assess as appropriate the cybersecurity posture for Category 1 and Category 2 quantities of radioactive material. As part of this assessment, the licensee should follow the cybersecurity practices documented in Information Notice 2019-04, “Effective Cyber Security Practices to Protect Digital Assets of Byproduct Materials Licensees” (ADAMS Accession No. ML18044A350), which provides information for effectively protecting digital assets.

Response from Applicant: No response is required from an applicant or licensee. If 10 CFR Part 37 applies, compliance with access authorization and security program requirements may be reviewed during NRC inspections.

8.11 Item 11: Waste Management

Regulations: 10 CFR 20.1101, 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 20.1501, 10 CFR 20.1904, 10 CFR 20.1906, 10 CFR 20.2001, 10 CFR 20.2002, 10 CFR 20.2003, 10 CFR 20.2004, 10 CFR 20.2005, 10 CFR 20.2006, 10 CFR 20.2007, 10 CFR 20.2008, 10 CFR 20.2108, 10 CFR Part 20 Appendix G, 10 CFR 30.35, 10 CFR 30.41, 10 CFR 30.51, 10 CFR 35.92

Criteria: The radiation protection program that licensees are required to develop, document, and implement in accordance with 10 CFR 20.1101 must include provisions for waste disposal of licensed material. Licensed materials must be disposed of in accordance with NRC requirements by one of the following methods:

- transfer to an authorized recipient (10 CFR 30.41, 10 CFR 20.2006, 10 CFR 20.2008);
- decay-in-storage (10 CFR 35.92);
- release in effluents within the limits in 10 CFR 20.1301; or
- as authorized under 10 CFR 20.2002 through 20.2005.

Waste must be disposed of in accordance with regulatory requirements and license conditions. Licensees are responsible for ensuring that waste is transferred only to authorized recipients. All radioactive waste must be stored in appropriate containers until its disposal, and the integrity of the waste containers must be assured. Radioactive waste containers must be appropriately labeled. All radioactive waste must be secured against unauthorized access or removal. Appropriate financial assurance for waste disposal at the time of decommissioning must be provided. Appropriate records of waste disposal must be maintained.

Discussion: This section addresses radioactive waste resulting from (1) the use of byproduct material in a fusion system or (2) the production, extraction, or conversion after extraction of byproduct material from a fusion system for a commercial, medical, or research activity. The applicant should discuss the methods for management and disposal of radioactive waste, including minimization, characterization, handling, secure storage, and disposal.

Appropriate training should be provided to waste handlers. U.S. Environmental Protection Agency guidance for developing a comprehensive program to reduce hazardous waste was transmitted to licensees by the NRC in IN 94-23, “Guidance to Hazardous, Radioactive, and Mixed Waste Generators on the Elements of a Waste Minimization Program,” dated March 1994. The application should include, where appropriate for the types of waste involved, provisions for monitoring and segregating waste materials (e.g., radioactive from nonradioactive, short from long half-life, liquid from solid waste).

The applicant should adopt procedures that will minimize the volume of waste being transferred to disposal facilities. The NRC policy statement, “Low-Level Radioactive Waste Management and Volume Reduction,” dated May 2012, addresses issues that the applicant should consider when developing volume reduction procedures. The NRC recognizes that volume reduction is only one aspect of an effective waste management program. As part of ensuring public health and safety, licensees should consider reductions in occupational exposures and security in determining how best to manage waste. Licensees also may consider operational efficiency and cost as part of their waste management strategies.

Licensees required to provide a Decommissioning Funding Plan (DFP) by 10 CFR 30.35 should account for the cost of disposing of waste generated by decommissioning or otherwise managed at the time of decommissioning in the DFP. NUREG-1757 Volume 3, Revision 1, "Consolidated Decommissioning Guidance Financial Assurance, Recordkeeping, and Timeliness," provides guidance on developing a DFP.

Although the Commission continues to favor the disposal of low-level radioactive waste (LLW) over storage, it recognizes that licensees may safely manage waste in a variety of ways, consistent with NRC regulations and guidance. The applicant may consider the methods of waste disposal listed under "criteria" above and discussed further in the following subsections. The licensee should address the anticipated methods of waste disposal in the application, as appropriate.

Transfer to an Authorized Recipient

Licensees may transfer radioactive waste to an authorized recipient for disposal. The licensee is responsible for verifying that the intended recipient is authorized to receive the radioactive waste in accordance with 10 CFR 20.2001(a) before shipment. Each shipment must comply with all applicable NRC and DOT requirements.

A licensee transferring waste to an authorized disposal facility under 10 CFR 20.2006 or § 20.2008 should ensure that the waste meets the disposal facility's waste acceptance criteria (WAC). In addition, a licensee transferring fusion system waste to an authorized disposal facility under § 20.2008 is responsible for demonstrating that either:

- the waste has a similar physical form, chemical characteristics, and radionuclide concentrations as the waste considered in the development of the NRC licensing requirements for land disposal of radioactive waste (10 CFR Part 61); or
- the disposal site licensee has completed a site-specific inadvertent intrusion assessment that considers the form of and radionuclides in the fusion system waste.

The waste classification tables in 10 CFR 61.55 are part of the NRC regulatory framework to protect an individual who could inadvertently intrude into a LLW disposal facility after closure[1]. However, during the development of the waste classification tables, the NRC may not have considered all the potential wasteforms and radionuclides that could be generated by fusion systems. Therefore, to ensure protection of an inadvertent intruder, 10 CFR 20.2008(c) requires that disposal site licensees that accept fusion system waste that is significantly different from waste considered during the development of the waste classification tables perform a site-specific inadvertent intrusion assessment. In that context, a waste is "significantly different" from waste considered during the development of the waste classification tables if it is in a novel physical or chemical form, or if it contains radionuclides that were not considered quantitatively during the development of the 10 CFR 61.55 waste classification tables.

[1] In comparison, the 10 CFR Part 61 requirements for protection of the general population from releases of radioactivity and protection of individuals during operations rely on assessments of the actual forms and radionuclide concentrations of the waste. Therefore, any novel properties of fusion system wastes that affect radionuclide release from a disposal site or the dose to individuals during disposal site operations must be evaluated by the disposal site operators to determine waste acceptability. Those analyses would be similar to analyses disposal site operators routinely conduct for non-fusion waste to determine waste acceptability.

Wasteforms considered during the development of 10 CFR Part 61 include wasteforms that may be generated by fusion systems, such as activated metal, cement-solidified liquids, polymer-solidified liquids, contaminated soil, contaminated equipment, contaminated building rubble, ion-exchange resins, incinerator ash, and calcined waste. Additional wasteforms considered during the development of 10 CFR Part 61 are described in Section 3.4 of NUREG-0782, Volume. 2, "Draft Environmental Impact Statement on 10 CFR Part 61 'Licensing Requirements for Land Disposal of Radioactive Waste.'"

Table 8-XX, below, shows the radionuclides the NRC considered quantitatively during the development of 10 CFR Part 61. The table includes radionuclide concentrations that the NRC staff calculated to protect individuals from inadvertent intrusion at that time. Table 8-XX provides guidance for determining when a site-specific inadvertent intrusion analysis is needed. For example, a disposal site that accepts fusion system waste that contains only the radionuclides in Table 8-XX at concentrations below the constraints listed in the table would not need to perform a site-specific intrusion analysis.

Table 8-XX provides constraints based on waste class because some regulatory requirements for inadvertent intruder protections depend on the waste class (e.g., solidification, intrusion barrier, depth of burial). However, Table 8-XX includes some values that are not part of the 10 CFR 61.55 waste classification tables. Those values calculated with the same calculations and data sources the NRC used to develop 10 CFR Part 61 but were not included in the waste classification tables to facilitate implementation of 10 CFR Part 61 when it was originally promulgated. The NRC staff subsequently determined the values provide a consistent level of safety for an inadvertent intruder as the values in 10 CFR Part 61.55. Although Table 8-XX references the waste class, it does not affect waste classification. The waste class is determined based on requirements of 10 CFR 61.55. Furthermore, Table 8-XX does not affect the appropriate timeframe for a disposal site licensee to demonstrate compliance with 10 CFR 61.41, "Protection of the general population from releases of radioactivity."

To assess whether radionuclides other than those in Table 8-XX are present in fusion system waste, licensees should use the guidance in NUREG/BR-0204 for providing a radiological description of a waste. That is, a licensee should consider a radionuclide to be present in waste if it meets any of the following criteria:

- The concentration is greater than 0.01 times the concentration limit for that radionuclide in the disposal facility WAC;
- The radionuclide does not appear in 10 CFR 61.55 tables or the disposal facility WAC and the concentration is greater than 0.26 megabecquerel (MBq) per cubic centimeter;
- The activity represents a reportable quantity under DOT regulations (see 49 CFR 172.101, Appendix A, "Office of Hazardous Materials Transportation Color Tolerance Charts and Tables"); or
- The activity is 0.01 or more of the total activity within the disposal container.

The NRC recognizes that in some cases the threshold based on the above criteria may be below a practical detection level. In accordance with 10 CFR 61.55(a)(8), the reported activity of a radionuclide can be derived from the lower limit of detection value or by indirect methods (e.g., scaling factors). The use of indirect methods is acceptable if there is reasonable assurance that the indirect methods can be correlated with measurements.

If a licensee determines there are radionuclides in the waste that were not considered quantitatively during the development of the 10 CFR 61.55 waste classification tables, the licensee must ensure the disposal site has completed a site-specific intrusion assessment that considers the radionuclides in the fusion system waste. The site-specific intrusion assessment must demonstrate that individuals who inadvertently intrude into the waste after the period of active instructional controls (e.g., typically 100 years after disposal site closure) will not receive a dose greater than 5 millisieverts (mSv) from the waste. Guidance on performing a site-specific intrusion assessment is available in the NRC Draft NUREG-2175, "Guidance for Conducting Technical Analyses for 10 CFR Part 61."

Table 8-XX. Radionuclides considered quantitatively during the development of 10 CFR 61.55 with constraints below which a site-specific intrusion assessment is not needed.

Radionuclide		Constraint if Disposed with Specified Waste Class			Basis
	Unit[a]	Class A	Class B	Class C	
Sum of Radionuclides with less than a 5-year half-life	Ci/m^3	700	No limit	No limit	b, c
H-3	Ci/m^3	40	No limit	No limit	b
C-14	Ci/m^3	0.8	0.8	8	b
C-14 in activated metal	Ci/m^3	8	8	80	b
Cl-36	Ci/m^3	110	110	1100	d
Co-60	Ci/m^3	700	No limit	No limit	b
Ni-59	Ci/m^3	2.2	2.2	22	e
Ni-59 in activated metal	Ci/m^3	22	22	220	b
Ni-63	Ci/m^3	3.5	70	700	c
Ni-63 in activated metal	Ci/m^3	35	700	7,000	b
Sr-90	Ci/m^3	0.04	150	7,000	b
Nb-94	Ci/m^3	0.002	0.002	0.02	e
Nb-94 in activated metal	Ci/m^3	0.02	0.02	0.2	b
Tc-99	Ci/m^3	0.3	0.3	3	b
I-129	Ci/m^3	0.008	0.008	0.08	b
Cs-135	Ci/m^3	84	84	840	e
Cs-137	Ci/m^3	1	44	4,600	b
Eu-152	Ci/m^3	0.06	6.2	No limit	d
Eu-154	Ci/m^3	0.02	1.5	5,100,000	d
U-235	Ci/m^3	0.04	0.04	0.4	e
U-238	Ci/m^3	0.05	0.05	0.5	e
Np-237	nCi/g	10	10	100	f
Pu-241	nCi/g	350	350	3,500	b
Pu-238, Pu-239, Pu-240, Pu-242, Am-241, Am-243, Cm-243, Cm-244	nCi/g	10	10	100	g
Cm-242	nCi/g	2,000	2,000	20,000	b

(a) To convert to curies to becquerel, multiply by 3.7×10^{10}.
(b) Values in 10 CFR 61.55.
(c) Analyses performed during the development of 10 CFR Part 61 and subsequent NRC staff analyses confirming analysis was bounding for other radionuclides with a half-life less than 5 years.
(d) Values calculated with the codes and data used during the development of 10 CFR Part 61. The NRC staff determined these values provide a level of protection provided by that regulation.

(e) Values calculated during the development of 10 CFR Part 61. The NRC staff determined these values provide a level of protection provided by that regulation.
(f) During the development of the waste classification tables, Np-237 was grouped with other alpha emitting transuranic nuclides despite having a lower calculated dose constraint because the NRC staff did not expect it to be present in significant quantities in LLW. Subsequent NRC staff calculations found that changes in dosimetry after the development of the waste classification tables reduced the projected dose such that it is not expected to pose excess risk to an inadvertent intruder if disposed of at the existing waste classification limits for alpha emitting transuranic nuclides with half-life greater than 5 years.
(g) Values calculated for individual radionuclides during the development of 10 CFR Part 61 were found sufficiently similar to be combined as “alpha emitting transuranic nuclides with half-life greater than 5 years.”

A model procedure for determining whether a site-specific intrusion analysis is required for a disposal facility accepting fusion system waste is contained in Appendix X of this NUREG, “Model Waste Management Procedures.”

Decay in Storage

The NRC has concluded that materials with half-lives of less than or equal to 120 days are appropriate for decay in storage. The holding time of the waste should be based on the radionuclide(s), half-life, and the activity present when the waste was placed into storage.

Licensees should review Regulatory Issue Summary 2004-17, Revision 1, “Revised Decay-In-Storage Provisions for the Storage of Radioactive Waste Containing Byproduct Material,” dated September 2005.

Waste that has been decayed in storage may be disposed of as ordinary trash if radiation surveys of the waste indicate that radiation levels are indistinguishable from background. The surveys should be performed with an appropriate radiation detection meter set on its most sensitive scale in a low background area and without any interposed shielding. In accordance with 10 CFR 20.1904(b), all radiation labels must be defaced or removed from containers and packages prior to disposal as ordinary trash. If the decayed waste is compacted, all labels that are visible in the compacted mass must also be defaced or removed.

Applicants must maintain accurate records of such disposals.

Applicants should ensure that adequate space and facilities are available for the storage of such waste, and care should be taken to ensure that the waste form does not degrade or interact adversely with the waste container. Procedures for management of waste by decay in storage should include methods of segregation, surveys before disposal, and maintenance of records of disposal.

Licensees can minimize the need for storage space if radioactive waste is segregated according to physical half-life. Segregation of waste is accomplished by depositing radionuclides of shorter physical half-lives in containers separate from those used to store radioactive waste with longer physical half-lives. Radioactive waste with shorter half-lives will take less time to decay and, thus, may be disposed of in shorter time periods, freeing storage space. The holding time of the waste should be based on the radionuclide(s), half-life, and the activity present when the waste was placed into storage.

The NRC does not consider storage as a substitute for final disposal of radioactive wastes. Storage other than for decay in storage should be used for no longer than necessary. Additional guidance is provided in this section under “Extended Interim Storage”.

A model procedure for decay in storage is contained in Appendix M of this NUREG, “Model Waste Management Procedures.”

Release into Air and Water

Release of radioactive material into air and water must conform to the requirements described in 10 CFR 20.1302(b)(2). The applicant should discuss the monitoring and control mechanisms in place to ensure compliance with the requirements. Applicants are reminded of the “constraint” on air emissions of radioactive material required by 10 CFR 20.1101(d), which effectively reduces the limits specified in 10 CFR 20.1302(b)(2) for release of gaseous effluents by a factor of 10. Applicants considering release of radioactive material into air and water should review Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities,” on the application of ALARA in controlling gaseous and liquid effluents and references documents with acceptable methods of effluent monitoring.

Licensees considering disposal by release to the sanitary sewerage system must comply with the requirements of 10 CFR 20.2003. Licensees are responsible for demonstrating that licensed materials discharged into the sewerage system are readily soluble or biologically readily dispersible in water. In NRC IN 94-07, “Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR 20,” criteria are provided for evaluating the solubility of liquid waste. Liquid scintillation media and ash are examples of material that may or may not be readily dispersible. Licensees should carefully consider the possibility of reconcentration of radionuclides that are released into the sewage system. The NRC alerted licensees to the potentially significant problem of reconcentration of radionuclides released to sanitary sewage systems in NRC IN 84-94, “Reconcentration of Radionuclides Involving Discharges into Sanitary Sewage Systems Permitted Under 10 CFR 20.303 [now 10 CFR 20.2003].”

Applicants should provide procedures that will ensure that all releases of radioactive waste into the sanitary sewerage system meet 10 CFR 20.2003 criteria and do not exceed the monthly and annual limits specified in the regulations. Licensees are required to maintain accurate records of all releases of licensed material into the sanitary sewerage system. A model procedure for disposal of radioactive waste via a sanitary sewer is described in Appendix X.

The regulations at 10 CFR 20.2003 are not applicable for releases to a private sewerage treatment system, a septic system, or leach fields. Licensees may make releases to these systems as effluents released to unrestricted areas under 10 CFR 20.1301, “Dose limits for individual members of the public.” However, if licensed material is released to a private sewerage treatment system, septic system, or leach field, the sludge or other solids from these systems may become contaminated with radioactive material. Such sludges may be required to be disposed of as radioactive waste, using one of the methods described in this Section. Licensees should account for the cost of disposal of such sludges in a DFP, if one is required. As indicated above, NUREG-1757 Volume 3, Revision 1, “Consolidated Decommissioning Guidance Financial Assurance, Recordkeeping, and Timeliness,” provides guidance on developing a DFP.

Incineration

Applicants who wish to treat or dispose of licensed material by incineration must comply with the requirements of 10 CFR 20.2004. Applicants proposing incineration should be aware that a notice in the *Federal Register* may be required before disposal of ash as ordinary waste can be approved. However, approval of incineration pursuant to 10 CFR 20.2004 does not require notice in the *Federal Register* if the ash is disposed as radioactive waste or transferred to a specific licensee. Policy and Guidance Directive PG 8-10, "Disposal of Incineration Ash as Ordinary Waste," dated January 1997, provides guidance on the disposal of ash. A model procedure for waste incineration is described in Appendix M of this NUREG.

Applicants considering disposal of radioactive material by incineration should review Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities." Regulatory Guide 8.37 deals with the application of ALARA in controlling gaseous and liquid effluents and references documents containing acceptable methods of effluent monitoring.

Waste Volume Reduction

Licensees should review the NRC Policy Statement, "Low-Level Radioactive Waste Management and Volume Reduction," dated May 2012. In general, licensees should implement procedures to reduce the volume of radioactive waste for final disposal in an authorized disposal facility. However, the NRC recognizes that volume reduction is only one aspect of an effective waste management program. As part of ensuring public health and safety, licensees should consider reductions in occupational exposures and security in determining how best to manage waste. Licensees also may consider operational efficiency and cost as part of their waste management strategies.

Procedures to minimize waste volumes include segregating, consolidating, compacting, or allowing certain waste to decay in storage. Waste compaction or other treatments can reduce the volume of radioactive waste, but such processes may pose additional radiological hazards (e.g., airborne radioactivity or increased radiation levels) to workers, members of the public, and the environment. Safety procedures to address these concerns should be implemented.

Other Methods Specifically Approved by NRC Under 10 CFR 20.2002

Applicants may also request alternate methods for the disposal of radioactive waste generated at their facilities. Such requests must describe the waste-containing licensed material, including the physical and chemical properties that may be important to assess risks associated with the waste, and describe the proposed manner and conditions of waste disposal. Additionally, the applicant must submit its analysis and evaluation of pertinent information on the nature of the environment, nature and location of other affected facilities, and procedures to ensure that radiation doses are maintained ALARA and within regulatory limits. If the waste is transferred for disposal, the licensee is responsible for ensuring that the waste recipient meets the requirements of 10 CFR 20.2008, as described under "Transfer to an Authorized Recipient," above.

If implementation of the alternative disposal method could affect additional governmental jurisdictions, the licensee should refer to State and Tribal Communication Letter FSME 12-025, dated March 13, 2012, "Clarification of the Authorization for Alternative Disposal of Material Issued Under 10 CFR 20.2002 and Exemption Provisions in 10 CFR" (ADAMS Accession No. ML12065A038).

Additional Considerations

The application should describe the considerations given to maintaining doses ALARA before disposal of radioactive materials and discuss the potential for unmonitored or unanticipated release of radioactive materials from likely release points (e.g., hoods and incinerator stacks) to work areas. To comply with the ALARA philosophy stated in 10 CFR 20.1101, "Radiation protection programs," radioactive material waste stream concentrations should be a fraction (generally 10 percent to 20 percent) of the limits specified in 10 CFR Part 20, Appendix B, Table II. Furthermore, due to the variability of inventory control programs for monitoring disposal and releases of licensed material possessed, or possessed and in use, a program for physically measuring releases should be in place whenever releases exceed the specified point at which expected doses might warrant additional review to ensure that they remain ALARA.

Because of the difficulties and costs associated with disposal of sealed sources, applicants should preplan their disposal. As part of the purchase agreement with the source supplier, applicants may want to consider including provisions for return of the sealed sources to the supplier at the end of the useful life of the sources.

Before licensed activities are transferred or assigned in accordance with 10 CFR 30.34(b), if licensees are authorized to possess byproduct material with a half-life greater than 120 days in an unsealed form, the licensees must, in accordance with 10 CFR 30.51(e), transfer the following records to the new licensee:

- records of disposal of licensed material made under:
  - — 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures"
  - — 10 CFR 20.2003, "Disposal by release into sanitary sewerage"
  - — 10 CFR 20.2004, "Treatment or disposal by incineration"
  - — 10 CFR 20.2005, "Disposal of specific wastes"
- records required by 20.2103(b)(4) of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment

Extended Interim Storage

The NRC does not consider interim or long-term storage as a substitute for final disposal of LLW. Licensees should exhaust all possible alternatives for disposal of radioactive waste and rely upon on-site extended interim storage of radioactive waste only as a last resort. The protection of workers and the public is enhanced by disposal rather than storage of waste. Licensees may also find it more economical to dispose of radioactive waste than to store it on site because as the available capacity decreases, the cost of disposal of radioactive waste may continue to increase. Other than decay in storage, LLW should be stored only when disposal capacity is unavailable and for no longer than is necessary. NRC IN 90-09, "Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees," dated February 5, 1990, provides guidance to licensees for requesting an amendment to authorize extended interim storage of LLW. Regulatory Issue Summary 2008-12, "Considerations for Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees," dated May 9, 2008, updates information provided in IN 90-09. In addition, the NRC issued Regulatory Issue Summary 2011-09, "Available Resources Associated with Extended

Storage of Low-Level Radioactive Waste," dated August 16, 2011, which refers to other helpful guidance documents.

Response from Applicant: Provide procedures for waste collection, handling, storage, and disposal by any of the authorized methods described in this section. If waste is to be disposed of by transfer to an authorized recipient, provide a description of the anticipated waste and an assessment of whether the waste has novel physical, chemical, or radiological characteristics.

Provide plans for financial assurance for waste disposal during decommissioning if required under 10 CFR 30.35. Applicants should contact the appropriate NRC Regional Office for guidance and obtain advance approval of any method(s) of waste disposal other than those discussed in this section.

The applicant should request authorization for extended interim storage of waste, if applicable. The applicant should refer to NRC IN 90-09, "Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees," dated February 1990, for guidance and submit the required information with the application.

APPENDIX G

METHODOLOGY FOR DETERMINING PUBLIC DOSE

Methodology for Determining Public Dose

This appendix describes methods for determining radiation doses to members of the public. Licensees must ensure that:

- The radiation dose received by individual members of the public does not exceed 1 millisievert (mSv) [100 millirem (mrem)] in one calendar year resulting from the licensee's possession or use of licensed materials.
- The radiation dose in unrestricted areas does not exceed 0.02 mSv [2 mrem] in any one hour.
- Air emissions of radioactive materials to the environment, excluding radon-222 and its daughters, do not result in a total effective dose equivalent (TEDE) in excess of 0.1 mSv [10 mrem] per year. As required in 10 CFR 20.1101(d), if the licensee exceeds this 0.1 mSv [10 mrem] per year air emission dose constraint, the licensee shall report the exceedance as provided in 10 CFR 20.2203, and promptly take appropriate corrective action to ensure against recurrence.

Members of the public include persons who live, work, study, or may be near locations where byproduct material is used or stored, and employees whose assigned duties do not include the use of licensed material but who may work in the vicinity where such materials are used or stored.

Doses to Members of the Public	
INCLUDE doses from • Radiation or radioactive material released by a licensee • Sources of radiation under the control of a licensee • Air effluents from sources of licensed radioactive materials • Licensed material in transportation or storage at the licensee's facility	DO NOT INCLUDE doses from • Sanitary sewerage discharges from licensee activities done in accordance with 10 CFR 20.2003, "Disposal by release into sanitary sewerage" • Natural background radiation • Medical administration of radioactive material including patients released under 10 CFR 35.75 • Voluntary participation in medical research

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As defined in 10 CFR 20.1003, the term *unrestricted area* means "an area, access to which is neither limited nor controlled by the licensee." For purposes of this definition in 20.1003, an "unrestricted area" is an area where access is neither limited nor controlled by the licensees for purposes of limiting exposures to radiation and radioactive materials. An "unrestricted area" for purposes of 20.1003 may be controlled for other purposes, such as for security purposes (see, e.g., 10 CFR 20.1801 and 20.1802), and still be considered an "unrestricted area" as long as it is not required to be controlled for limiting exposure to radiation and radioactive materials. Typical unrestricted areas may include offices, shops, areas outside buildings, property, and storage areas for non-radioactive materials, and other facilities and laboratories where licensed materials are not normally used or stored.

The licensee must show compliance with the annual dose limit for individual members of the public by

- Demonstrating by measurement or calculation that the TEDE to the individual likely to receive the highest dose, in an unrestricted area from licensed operations, does not exceed 1 mSv [100 mrem] in a year, or
- Demonstrating that the annual average concentration of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area does not exceed the values specified in 10 CFR Part 20, Appendix B, Table 2, "Effluent Concentrations." The licensee must also show that if an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv [2 mrem] in an hour and 0.5 mSv [0.05 rem] in a year, and

To perform a dose assessment, the licensee should identify all potential sources of external and internal radiation exposure to members of the public and all locations of use, transport, and storage of radioactive material at the facility. The licensee must then take radiation measurements or perform calculations to demonstrate compliance.

Measurements

The licensee may use measurements to demonstrate that the average annual releases are within regulatory limits, as well as demonstrate that the TEDE to the individual likely to receive the highest dose at the boundary of the unrestricted area does not exceed 1 mSv [100 mrem] in a year. These measurements may include:

- dose rate surveys for radiation exposures from external radiation sources
- measurements of radionuclides in air and water effluents
- use of environmental dosimeters in unrestricted areas

The method used to measure dose will depend on the nature of the radiation source. If the source of radiation is constant, it may be adequate to measure the dose rate and integrate it over time. If the source of radiation differs or changes over time, it may be necessary to perform continuous measurements.

Radioactivity releases may be determined by effluent monitoring or by effluent sampling and analysis. Airborne effluents may be discharged during accelerator operation. Due to the

uncertainty of this type of discharge, it may be important to perform effluent monitoring continuously or at least during the operation of the accelerator. Liquid effluents may be discharged continuously or may be stored and subsequently discharged on a batch basis. For each type of source and for each route of potential exposure, consider the location of measurement points, whether continuous or periodic monitoring is required, the frequency of sampling and measurement, and any additional information. For discharges of airborne radionuclides, for example, it may be necessary to obtain information on the efficiency of filters and the air-flow rate of the discharge system, as well as meteorological data and the distance to the nearest individual member of the public.

Calculation Method

Using a calculation method, the licensee must determine the highest dose an individual is likely to receive in an unrestricted area from licensed operations. The licensee must take into account the individual's exposure from external sources and the concentration of radionuclides in gaseous and liquid releases. In practice, the licensee may wish to make conservative assumptions to simplify the dose calculation.

The public dose limit applies to the individual who is likely to receive the highest dose from licensed operations. Therefore, the dose calculations must consider the location with the potential for the highest internal and external exposures. The occupancy factor for an area is defined as the average fraction of time the maximally exposed individual is present and exposed to a radiation source. If a source is used intermittently, the occupancy factor is a fraction of the hours in a week that a given person would occupy the area. If the result of the calculation using an occupancy factor of 1 demonstrates that the public dose limit is not exceeded, then there is no need for further evaluation.

If, however, the licensee would rather choose a more realistic assumption of the individual's occupancy at the points of highest internal and external exposures, then the licensee may use the occupancy factors in Table G–1 or may calculate a specific occupancy factor by determining the likely fraction of time that the individual is present. The occupancy factors in Table G-1 are general guidance values and may be used if more detailed information is not available.

Table G–1. Standard Occupancy Factors[2]

Occupancy Factor	Description
1	Full occupancy areas such as administrative and clerical offices, receptionist areas, laboratories, pharmacies and other work areas fully occupied by an individual, attended waiting rooms, and occupied space in nearby buildings
1/2	Rooms where individuals are present for a major part of the day
1/5	Corridors, employee lounges, staff rest rooms and classrooms

[2] Adapted from NCRP Report No. 147, "Structural Shielding Design for Medical X-Ray Imaging Facilities," issued November 19, 2004 and NCRP Report No. 151, "Structural Shielding Design and Evaluation for MegaVoltage X- and Gamma-Ray Radiotherapy Facilities," issued December 31, 2005

Table G–1. Standard Occupancy Factors[2]	
Occupancy Factor	**Description**
1/20	Unattended waiting rooms, public rest rooms, unattended vending rooms, storage areas, janitor's closets, attics, outdoor areas with seating, and recreational areas
1/40	Outdoor areas with only transient pedestrian or vehicular traffic, unattended parking lots, vehicular drop off areas (unattended), stairways, and unattended elevators

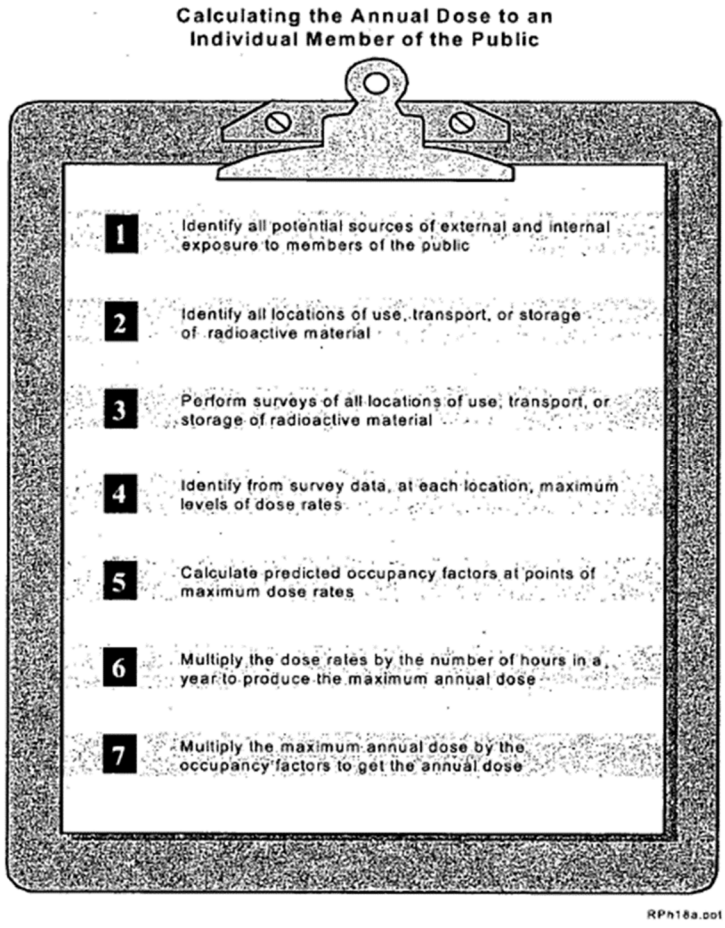

Figure X-X

Records

In accordance with 10 CFR 20.2107, "Records of dose to individual members of the public," the licensee must maintain records to demonstrate compliance with the dose limit for individual members of the public until the Commission terminates the license. In general, radiation survey and monitoring records of ambient radiation and effluent radioactivity should be adequate.

Records demonstrating the dose to an individual member of the public should identify the instruments used in the survey, the name of the surveyor, the date of the survey, the location of the survey(s) including a description or drawing of the areas surveyed, survey results, and if applicable, the occupancy factors used and justification for their use. In addition, records demonstrating the dose to an individual member of the public that involve effluent sampling analysis should include information on concentrations of specific radionuclides, minimum detectable activity of the system, and the estimated uncertainty of measurements.

APPENDIX M

MODEL WASTE MANAGEMENT PROCEDURES

Model Waste Management Procedures

General Guidelines

- Periodically review all procedures to ensure that radioactive waste is not created unnecessarily. For example, procedures should minimize contamination of equipment to avoid waste generation. In addition, procedures should indicate that nonradioactive waste should not be mixed with radioactive waste. Review new procedures to ensure consistency with established waste management procedures.
- Consider the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and costs.
- Provide waste handling procedures for users within their assigned areas, and for waste handlers who may collect waste from areas of use to bring to a storage area for eventual disposal. Those procedures should be part of the waste management program.
- Provide housekeeping staff with adequate training to avoid the possibility of unauthorized disposal or exposure of these individuals to radioactive materials or radiation.
- Ensure records are kept for transfer and disposal of byproduct material in accordance with 10 CFR 30.51(a), "Records."
- Before transferring any licensed byproduct material, verify that the recipient is authorized to receive the licensed material, as required by 10 CFR 30.41 (e.g., obtain a copy of the transferee's U.S. Nuclear Regulatory Commission license or Agreement State license that authorizes the byproduct material). For transfers to a low-level radioactive waste (LLW) disposal facility under 10 CFR 20.2008, review the additional guidance under "Model Procedure for Transfer of Licensed Material to Authorized Recipient for Near-Surface Disposal," below.

Model Procedure for Decay in Storage

Regulations in 10 CFR 35.92, "Decay-in-storage," describe the requirements for decay in storage. Applicants should ensure that adequate space and facilities are available for the storage of waste. Storage should be designed to allow for segregation of wastes with different half-lives (e.g., multiple shielded containers). Containers should have shielded covers to maintain occupational exposure at as low as is reasonably achievable (ALARA) levels. Storage areas must be in a secure location.

- Only waste with a physical half-life of less than or equal to 120 days may be disposed of by decay in storage. Waste with a half-life of greater than 65 days but less than or equal to 120 days should be segregated at the source of generation from waste that has a half-life of less than or equal to 65 days.

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- Waste should be stored in suitable well-marked containers, the containers should provide adequate shielding, and the waste's physical form should be compatible with the waste container.
- Liquid and solid wastes should be stored separately.
- Filled containers should be sealed. Sealed containers should be labeled in accordance with 10 CFR 20.1904 and 10 CFR 20.1905. The identification label should include the date when the container was sealed, the longest-lived radionuclide in the container, total activity, and the initials of the individual who sealed the container. The container may then be transferred to the decay in storage area.
- The contents of the container should be allowed to decay for a time after which it is expected that the radiation levels would not be distinguishable from background. The time depends on both the half-life of the radionuclide(s) and the original amount present.
- Prior to disposal as ordinary trash, each container should be monitored as follows:
    - Check the radiation detection survey meter for proper operation with a radiation source.
    - Survey the contents of each container in a low background area.
    - Remove any shielding from around the container.
    - Monitor all surfaces of the container.
    - Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity (i.e., surface readings are indistinguishable from background readings). All radiation labels should be defaced or removed from containers and packages prior to disposal as ordinary trash.
    - If the surveys indicate residual radioactivity, return the container to the decay in storage area and contact the RSO for further instructions.
    - If the surveys indicate no residual radioactivity, record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

Note: When large quantities are held for decay in storage, measurable activities may be present even after many half-lives. Persons performing surveys should be aware of the potential for measurable radiation.

Model Procedure for Disposal of Liquids into Sanitary Sewerage

- Confirm that the sewer system is a public system, not a private sanitary sewer, septic system, or leach field.
- Confirm that the liquid waste being discharged is readily soluble (or is easily dispersible biological material) in water.
- Calculate the amount of each radionuclide that can be discharged by using the information from prior, similar discharges and the information in 10 CFR 20, Appendix B.
- Record the date, radionuclide(s), estimated activity of each radionuclide, location where the material is discharged, and the initials of the individual discharging the waste.

  - Make sure that the amount of each radionuclide does not exceed the monthly and annual discharge limits specified in 10 CFR 20.2003(a)(4) and 10 CFR Part 20, Appendix B, Table 3.
  - If more than one radionuclide is released, the sum of the ratios of the average monthly discharge of a radionuclide to the corresponding limit in 10 CFR Part 20, Appendix B, Table 3 should not exceed unity.
  - Make sure the total quantity of licensed material released into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of H-3 (tritium), 37 GBq (1 Ci) of C-14, and 37 GBq (1 Ci) of all other radionuclide combined.
- Liquid waste should be discharged only via designated sinks or toilets.
- Discharge liquid waste slowly to minimize splashing, with water running to dilute it and to ensure that the material moves out of the sink into the sewer system.
- Survey discharge areas and surrounding work surfaces to confirm that no residual material or contamination remains. Prior to leaving an area, decontaminate all areas or surfaces found to be contaminated.
- For all releases to the sanitary sewer from the licensed facility, maintain records of each radionuclide and the quantity and concentration that is released into the sewer system to demonstrate compliance with the regulatory limits for total quantity released and concentrations released by the licensed facility.

Model Procedure for Incineration

These guidelines apply to noncommercial waste disposal (e.g., incineration of a licensee's own waste) under 10 CFR 20.2004. Specific NRC approval is not necessary to incinerate certain categories of radioactive waste. For example, 10 CFR 20.2005 provides that tritium and carbon-14 in low level concentrations, in liquid scintillation media and animal tissue, may be disposed of without regard to radioactivity. Licensees must maintain records for waste disposals under 10 CFR 20.2004 and 10 CFR 20.2005 as required by 10 CFR 20.2108.

After reviewing the disposal program and confirming the existence of waste that requires specific NRC approval for incineration, provide the following information in the license application:

- Describe the training and experience of the person who will be responsible for the on-site and day-to-day supervision of incinerator operations.
- Describe the waste that is proposed to be incinerated, including:
  - a description of the chemical and physical form of the waste containing licensed material;
  - a description of how the waste is segregated, packaged, and labeled for transfer from the generation site to the incinerator;
  - names and concentrations of each radionuclide to be incinerated averaged over the weight of the material to be incinerated (microcurie per gram of waste medium); and
  - the total radioactivity of each radionuclide per burn and the total number of burns per year, including a description of procedures for ensuring that these frequencies and activities will not be exceeded.

- Describe the procedures for the packaging, handling, securing, and monitoring of waste to prevent contamination and unnecessary exposure to personnel or property during the waste life cycle.
- Describe the methods for measuring or estimating the concentration of radioactive material remaining in the ash residue. Describe the procedures for collection, handling, and disposal of the ash residue.
- Describe the recordkeeping procedures for the waste incineration program. Records should be adequate to document all receipts, incineration, environmental releases of effluents, and any disposals of ash generated in the incineration process. These records should be maintained in the same units as applicable regulations.
- Describe the characteristics of the incinerator and site location including:
  - height of the stack;
  - rated air flow (cubic feet per hour or similar units);
  - proximity of the stack or other discharge to occupied areas (e.g., residences, school, hospital);
  - distance to the nearest air intake ducts of adjacent buildings; and
  - description of any scrubbers, filters, or air cleaning equipment that is present.
- State how the concentration of radionuclides released, both as airborne effluent and as any liquid effluent from scrubbers, condensers, or associated systems, will be measured or otherwise determined. Describe any stack monitoring that is planned.
- Provide a copy of the written safety analysis that demonstrates that the applicant will be able to incinerate the types and quantities of radioactivity specified in the application without exceeding the environmental release limits specified in 10 CFR Part 20.
- Provide a written commitment that the applicant has coordinated with appropriate State and local authorities and that such permits and other authorizations as may be necessary have been obtained.
- Provide a copy of the radiation safety procedures for monitoring personnel involved in incineration operations, and for monitoring all effluent generated by the incineration process. The procedures should ensure that regulatory limits for environmental releases of radioactivity will not be exceeded. The applicant should describe disposal procedures for any ash generated exceeding regulatory limits.

Model Procedure for Compaction

The following information should be provided by licensees who propose to compact waste:

- Describe the compactor to demonstrate that it is adequately designed and manufactured to safely compact the type and quantity of waste generated during licensed operations (e.g., manufacturer's specifications, annotated sketches, photographs).
- Describe the type, quantities, and concentrations of waste to be compacted.
- Provide an analysis of the potential for airborne release of radioactive material during compaction activities.

- State the location of the compactor(s) within the waste processing area(s).
- Describe the ventilation and filtering systems used in conjunction with the compactors, including a description of the procedures for monitoring filter blockage and exchange.
- Describe the methods used to monitor worker breathing zones and exhaust systems.
- Describe the types and frequencies of surveys that will be performed for contamination control in the compactor area.
- Describe the instruction provided to compactor operators, including:
  - instructions for protective clothing;
  - checks for proper functioning of equipment;
  - methods of handling uncompacted waste; and
  - examination of containers for defects.
- Deface or remove all radioactivity labels that are visible in the compacted mass.

Model Procedure for Transfer of Licensed Material to Authorized Recipient for Near-Surface Disposal

Licensed material should not be transferred or shipped from one institution to another without the approval of the RSO. Such transfers must be packaged and labeled in accordance with Department of Transportation, NRC, or U.S. Postal Service Regulations, whichever is applicable. Licensees must maintain records for waste disposals under 10 CFR 20.2002 and 10 CFR Part 61 as required by 10 CFR 20.2108. That record-keeping requirement includes waste disposed of under 10 CFR Part 61 per the provisions of 10 CFR 20.2008.

Prior to any transfer from the license, the licensee must verify that the recipient is authorized to receive the licensed material, as required by 10 CFR 30.41.

- For transfers of waste to a low-level radioactive waste (LLW) disposal facility under 10 CFR 20.2008, document whether the waste differs significantly from the waste types and radionuclide concentrations considered during the development of 10 CFR Part 61:
  - State whether the waste is activated metal, cement-solidified liquids, polymer-solidified liquids, contaminated soil, contaminated equipment, contaminated building rubble, ion-exchange resin, incinerator ash, calcined waste, or another waste form described in Section 3.4 of NUREG-0782, Volume. 2, “Draft Environmental Impact Statement on 10 CFR Part 61 ‘Licensing Requirements for Land Disposal of Radioactive Waste’.”
  - If the waste is not one of the listed wasteforms, indicate that the disposal site licensee has performed a site-specific inadvertent intrusion assessment as required by 10 CFR 20.2008(c) to demonstrate that the waste is acceptable for disposal. Guidance on performing a site-specific intrusion assessment is available in the NRC Draft NUREG-2175, “Guidance for Conducting Technical Analyses for 10 CFR Part 61.”
  - Compare the radionuclides in the waste to the radionuclides in Table XX in Section 8.11. A licensee should consider a radionuclide to be present in waste if it

meets any of the following criteria, either by direct measurement or an indirect method (e.g., use of scaling factors):

- The concentration is greater than 0.01 times the concentration limit for that radionuclide in the disposal facility waste acceptance criteria (WAC);
- The radionuclide does not appear in 10 CFR 61.55 tables or the disposal facility WAC and the concentration is greater than 0.26 megabecquerel (MBq) per cubic centimeter;
- The activity represents a reportable quantity under DOT regulations (see 49 CFR 172.101, Appendix A, “Office of Hazardous Materials Transportation Color Tolerance Charts and Tables”); or
- The activity is 0.01 or more of the total activity within the disposal container.

o If the waste contains radionuclides that are not in Table XX of Section 8.11 or contains radionuclides in greater concentrations than the values in that table, the licensee should indicate that the disposal site has performed a site-specific inadvertent intrusion assessment as required by 10 CFR 20.2008(c).

- For any waste offered for transportation for disposal at a licensed LLW land disposal facility, prepare a Uniform Waste Manifest as required by 10 CFR Part 20, Appendix G, “Requirements for Transfers of Low-Level Radioactive Waste Intended for Disposal at Licensed Land Disposal Facilities and Manifests.” Licensees should consult NUREG/BR-0204 Rev.3, “Instructions for Completing the U.S. Nuclear Regulatory Commission’s Uniform Low-Level Radioactive Waste Manifest,” to complete forms required by 10 CFR Part 20 Appendix G.

APPENDIX N

RADIATION SAFETY TRAINING

Radiation Safety Training

This appendix is intended only as a guide for developing a training program. Individuals working with radionuclides may not require training on every topic provided. For example, housekeeping staff may need to know only what symbols to look for, which waste cans to empty, or which areas to enter or avoid. Conversely, laboratory technicians may require detailed information on particular topics. As a result, instruction for some individuals may be accomplished by providing a simple hand-out, whereas others may require extensive training, including a written exam to assess retention of the topics presented.

The licensee should determine whether the training succeeded in conveying the desired information and adjust the training program as necessary. This assessment may be performed by a written test or observation of the individual in the performance of assigned duties. Remedial training for missed test questions or other areas of apparent weakness should be conducted or additional formal training planned to cover deficient areas.

Frequency of Training

- before assuming duties with, or in the vicinity of, radioactive materials
- whenever there is a significant change in duties, regulations, or the terms of the license
- annually (refresher training)

General Information

A. Radiation safety

1. radiation vs. contamination
2. internal vs. external exposure
3. biological effects of radiation
4. as low as is reasonably achievable (ALARA) concept
5. use of time, distance, and shielding to minimize exposure
6. contact dose rates and dose rates at a distance from high-activity sources
7. dose reduction responsibilities

B. Regulatory requirements

1. radiation safety officer (RSO)
2. material control and accountability
3. personnel dosimetry
4. radiation safety program audits
5. transfer and disposal

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6. recordkeeping
7. radiation surveys
8. postings
9. labeling of containers
10. handling and reporting of incidents or events
11. licensing and inspection by the U.S. Nuclear Regulatory Commission (NRC)
12. need for complete and accurate information
13. employee protection
14. deliberate misconduct

Licensee-Specific Program Elements

A. authorized individuals and supervised individuals

B. worker-specific production activities (e.g., maintenance of the accelerator)

C. shipping

D. moving/transferring radionuclides to different areas or licensees

E. applicable regulations and license conditions

F. areas where radioactive material is used or stored

G. potential hazards associated with radioactive material in each area where the individuals will work

H. appropriate radiation safety procedures

I. licensee's in-house work rules (for instructions on laboratory safety and uses of radionuclides, see Appendix X of this NUREG)

J. each individual's obligation to report unsafe conditions to the RSO

K. appropriate response to spills, emergencies, or other unsafe conditions

L. worker's right to be informed of occupational radiation exposure and bioassay results, if applicable

M. Locations where the licensee has posted or made available: notices, copies of pertinent regulations, and copies of pertinent licenses and license conditions (including applications and applicable correspondence), as required by Title 10 of the Code of Federal Regulations (10 CFR) Part 19

N. Emergency procedures

1. RSO name and telephone number
2. immediate steps to prevent or control spread of contamination
3. clean-up instructions, decontamination

O. Survey program

1. radiation survey instrument accessibility

2. who is responsible
3. types, contamination, and areas
4. frequency
5. levels of contamination
6. personnel, hands, shoes
7. records

P. Waste

1. liquids
2. solids
3. air effluents from accelerator operation
4. sanitary sewer
5. burial (transfer to low-level waste repository)
6. storage
7. decay-in-storage
8. waste storage surveys
9. incineration
10. records

Q. Dosimetry

1. whole body
2. extremities
3. lens of the eye
4. lost or replacement badges and dose assessment
5. bioassay procedures
6. records

R. Instrumentation

1. radiation survey meters – use, calibration frequency, use of check sources
2. analytical instruments – gas-flow counters, liquid scintillation counters

S. Procedures for receiving packages containing radioactive materials (if applicable)

1. normal
2. off-duty
3. notification of user and RSO
4. security
5. exposure levels
6. possession limit
7. receipt of damaged packages

T. Sealed sources
    1. leak-test requirements
    2. inventory requirements
    3. exempt quantities
    4. records
U. NRC/State/Licensee audit findings
V. Other topics
W. Question and answer period

For Laboratory Safety and Use of Radionuclides

A. Control procedures for obtaining permission to possess or possess and use radioactive materials at the facility; give limitations on quantity to be handled per user, or allowed per experiment.
B. Protective clothing and what laboratory apparel to wear and what equipment to use.
C. Limitations and conditions relative to handling unsealed licensed material and what laboratory equipment to use when working with such material. For example, discuss which licensed materials and what procedures should be confined to radiochemical fume hoods or glove boxes. Explain what shielding or remote handling equipment should be used when beta- and/or gamma-emitting licensed materials are handled.
D. Routine radiation survey and monitoring procedures to be followed for contamination control. Include where and how contaminated articles and glassware are to be handled and stored.
E. Emergency procedures concerning spills, fires, release of material, and accidental contamination of personnel.
F. Decontamination procedures to use and whom to contact in case of an emergency.
G. Instructions concerning transfer of licensed materials between rooms, halls, or corridors, if applicable.
H. Requirements for storage, labeling of containers, and identification of areas where licensed materials are possessed or possessed and used.
I. Personnel monitoring devices to use, where to obtain them, and exchange procedures and exposure results.
J. Waste disposal procedures to follow, limitations for disposal of liquid or solid wastes, and procedures to use for waste storage. If the program involves experiments with animals, procedures for cleaning animal quarters and handling animal excreta and carcasses for disposal.
K. Records to be maintained on possession, use, and disposal of licensed materials.
L. Prohibitions of pipetting by mouth, eating, smoking, and drinking in areas where licensed materials are possessed or possessed and used.