West Valley Demonstration Project

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WVDP RADIOLOGICAL CONTROLS MANUAL

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DEPARTMENT OF ENERGY
Radiological Health and Safety Policy

It is the policy of DOE to conduct its radiological operations in a manner that ensures the health and safety of all its employees, contractors, and the general public. In achieving this objective, the Department shall ensure that radiation exposures to its workers and the public and releases of radioactivity to the environment are maintained below regulatory limits and deliberate efforts are taken to further reduce exposures and releases as low as reasonably achievable. The Department is committed to implementing high quality radiological control programs that consistently reflect this policy.

In meeting this policy, the Department shall:

A. **Establish and maintain a system of regulatory policy and guidance reflective of national and international radiation protection standards and recommendations.** The Chief Health, Safety and Security Officer has responsibility for promulgating and maintaining policies, standards, and guidance related to radiological protection. Departmental requirements often are more stringent and reflect, as appropriate, recommendations and guidance from various national and international standards-setting and scientific organizations, including the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, the American National Standards Institute, and others. Departmental requirements related to radiological protection will be set forth, as appropriate, in rules and Department of Energy Orders, and guidance documents will be issued on acceptable means to implement these requirements.

B. **Ensure personnel responsible for performing radiological work activities are appropriately trained.** Standards shall be established to ensure the technical competency of the Department's work force, as appropriate, through implementation of radiological training and professional development programs.

C. **Ensure the technical competence of personnel responsible for implementing and overseeing the radiological control program.** An appropriate level of technical competence gained through education, experience, and job-related technical and professional training is a critical component for achieving the goals of the Department's radiological control policy. Qualification requirements commensurate with this objective shall be established for technical and professional radiological control program positions and shall, at a minimum, be consistent with applicable industry standards and promote professional development and excellence in radiological performance as a goal.

D. **Establish and maintain, at all levels, line management involvement and accountability for departmental radiological performance.** The responsibility for compliance with Departmental radiological protection requirements, and for optimizing personnel radiation exposure, starts at the worker level and broadens as it progresses upward through the line organization. The Department's line managers are fully responsible for radiological performance within their programs and the field activities and sites assigned to them, and shall take necessary actions to ensure requirements are implemented and performance is monitored and corrected as necessary.

E. **Ensure radiological measurements, analyses, worker monitoring results and estimates of public exposures are accurate and appropriately made.** The capability to accurately measure and analyze radioactive materials and workplace conditions, and determine personnel radiation exposure, is fundamental to the safe conduct of radiological operations. Policy, guidance, and quality control programs shall be directed towards ensuring such measurements are appropriate, accurate, and based upon sound technical practices.

F. **Conduct radiological operations in a manner that controls the spread of radioactive materials and reduces exposure to the workforce and the general public and that utilizes a process that seeks exposure levels as low as reasonably achievable.** Radiological operations and activities shall be preplanned to allow for the effective implementation of dose and contamination reduction and control measures. Operations and activities shall be performed in accordance with departmental conduct of operations requirements and shall include reasonable controls directed toward reducing exposure, preventing the spread of radiological contamination, and minimizing the generation of contaminated wastes and the release of effluents.

G. **Incorporate features that minimize dose, contamination, and waste into the design of new facilities and significant modifications to existing facilities in the earliest planning stages.** Wherever possible, facility design features shall be directed toward controlling contamination at the source, eliminating airborne radioactivity, maintaining personnel exposure and effluent releases below regulatory limits and utilizing a process that seeks exposure levels and releases as low as reasonably achievable. Radiological design criteria should reflect appropriate consensus recommendations of national and international standards setting groups.

H. **Conduct oversight to ensure departmental requirements are being complied with and appropriate radiological work practices are being implemented**.

All departmental elements shall conduct their radiological operations in a manner consistent with the above policies and objectives.

IMPORTANT NOTE

DOE Policy 450.4 establishes DOE policy with regard to integrated safety management (ISM). The principles of ISM and relationship between DOE's ISM Policy and the provisions of this Standard are discussed in Article 118 of this Standard.

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PART 1. Department of Energy Radiological Control Standard

111 Radiological Health and Safety Policy

A key element of the Radiation Protection Guidance to the Federal Agencies for Occupational Exposure approved by President Reagan on January 20, 1987, and a fundamental principle underlying the Department of Energy (DOE) Radiological Control Standard is:

> *"There should not be any occupational exposure of workers to ionizing radiation without the expectation of an overall benefit from the activity causing the exposure."*

The DOE is firmly committed to having a radiological control program of the highest quality. This commitment is reflected in the DOE Radiological Health and Safety Policy reproduced at the beginning of the DOE Radiological Control Standard.

112 Standard Applicability and Control

DOE has established basic standards for occupational radiation protection in Federal regulation 10 CFR part 835, "Occupational Radiation Protection" (10 CFR 835). Section 835.101 of 10 CFR 835 requires affected DOE activities to be conducted in compliance with a documented radiation protection program (RPP) that addresses each requirement of that regulation. DOE's 441.1-1C Guide provides guidance for developing and implementing an RPP sufficient to ensure compliance with 10 CFR 835. The DOE 441.1-1C Guide is primarily directed toward radiological control organization professionals who are responsible for developing programs that will ensure regulatory compliance. The Guide therefore tends to provide flexibility for the use of professional judgment and is more technical and general in nature than this Standard. This Standard is primarily directed toward line management; it therefore discusses specific, detailed measures that should be implemented by line managers as they discharge their radiological control responsibilities. However, because both the DOE 441.1-1C Guide and this Standard discuss development and implementation of appropriate radiological controls, there are necessarily many overlaps. As a result, in the documented RPPs developed to ensure compliance with 10 CFR 835, most DOE facilities have committed to implementation of certain provisions of this Standard or its predecessor, the DOE Radiological Control Manual.

The radiological control program discussed in this Standard goes beyond the scope of, and includes more details than, the documented RPP required by 10 CFR 835. To ensure implementation of a comprehensive and coherent radiological control program that exceeds basic requirements and provides a substantial safety margin, DOE encourages its contractors to implement the provisions of this Standard to the extent appropriate to facility hazards and operations, consistent with DOE's Integrated Safety Management Program. Should any conflicts arise between the site-specific radiological control manual (based on this Standard, see Article 114), and the documented RPP, the requirements of the documented RPP should take precedence. Such conflicts should be expeditiously resolved.

The DOE Radiological Control Standard is not a substitute for regulations; it is intended to be consistent with all relevant statutory and regulatory requirements and will be revised whenever necessary to ensure such consistency. Some of the DOE Radiological Control Standard provisions, however, challenge the user to go well beyond minimum requirements.

The Standard is not a substitute for regulations; it is intended to be consistent with all relevant statutory and regulatory requirements and will be revised whenever necessary to ensure such consistency. Some of the Standard provisions, however, challenge the user to go well beyond minimum requirements.

This Standard is a living document. DOE intends to review and update provisions on a periodic basis to incorporate lessons learned and suggestions for improvement. The Chief Health, Safety and Security Officer is responsible for this task. Recommendations to correct or improve this Standard are encouraged and should be processed in accordance with DOE's published guidance for providing comments on documents in the DOE Technical Standards system.

113 Implementation

1. The DOE Radiological Control Standard sets forth DOE's views on the proper course of action in the area of radiological control within the scope of DOE-sponsored activities. The words "shall" and "should" have the meaning below when used in this Standard.

2. The word "shall" identifies those elements and requirements that DOE has considered and found to be mandatory due to their derivation from related regulatory requirements found in 10 CFR 835 or other regulations or DOE Orders. These requirements are indicated by a bracketed reference following the related Standard provision (e.g., [see 835.XXX]). For purposes of regulatory and contractual compliance, DOE encourages users of the Standard to refer to the source document to view the requirement in context and to determine the applicability of the requirement to the specific facility operations and hazards. Federal regulation 10 CFR Part 820, *Procedural Rules for DOE Nuclear Activities*, establishes requirements for obtaining exemptions from 10 CFR part 835. Due to its primary focus on line management implementation strategies, the Standard does not address all of the requirements of 10 CFR 835.

3. The word "should" means DOE has evaluated the provision and found that it is a proven practice or remedy that supports compliance with the basic requirements found in applicable regulations or DOE Orders or their underlying basis documents for occupational radiation protection. The use of "should" recognizes that: 1) there may be site- or facility-specific attributes that warrant special treatment; 2) the safety benefit derived from implementation of the provision may not in all cases be commensurate with the associated detriments (e.g., financial cost, worker discomfort, schedule impacts); and 3) literal compliance with the provision may not achieve the desired level of radiological control performance. Although a contractor may decide to follow an alternative technique, approach, or method in lieu of the "should" provision, DOE encourages implementation of these provisions to ensure compliance with the underlying basic requirements.

   A. **At the WVDP:** The word "should," as used in this manual, means WVES has the responsibility of either following the provision or demonstrating technical equivalency by an alternative solution. In those cases where WVES decides to follow an alternative technique, approach, or method in lieu of the "should" provision, the following actions are required:

      - The alternative solution shall be documented, with supporting technical basis, analysis, and justification to demonstrate technical equivalency.
      - Prior to implementation, the approval of the WVES Radiation Safety Manager and the WVES senior line manager responsible for operations.
      - The documented justification, including the required approvals, shall be readily retrievable for review and audit by DOE-WVDP.
      - At the conclusion of each calendar year, WVES shall provide to DOE-WVDP a tabulation of all such equivalency determinations approved within the past 12 months. For ease of reference, these may be referred to as Article 113 determinations.

4. The term "Article" is used to reference portions or sections of this document. For ease of communications, portions of this document should be referred to as Articles. For example, the appropriate reference to this Article is Article 113.4.

114 Site-Specific Manual

1. The contractor senior site executive should issue and endorse a site-specific radiological control manual that invokes the applicable provisions of this Standard. The site-specific radiological control manual does not require review or approval by DOE-Office of Health, Safety and Security. One approach in the development of site-specific radiological control manuals is to invoke the applicable provisions of this Standard as written with site specific additions, supplements, and clarifications clearly indicated, included in the appropriate chapters, and directly referenced to the corresponding article. The provisions of specific articles may be changed from “should” to “shall” on a site-specific basis as necessary to emphasize those measures that are deemed necessary for compliance or to ensure the desired level of safety. Additions and supplements to address unique situations or to provide more detailed or prescriptive direction may be included.

   A. **At the WVDP:** The development of the WVDP RCM **invokes the provisions of the DOE Radiological Control Standard (RCS) as written** with WVDP site-specific additions, supplements, and clarifications included in the appropriate chapters and directly referenced to the corresponding DOE RCS Article. Additions and supplements to address unique situations or more detailed or prescriptive direction have been included and do not conflict with or diminish the requirements of the DOE RCS.

   B. **At the WVDP:** The addition of site requirements within DOE RCS Article statements shall be indented from the DOE text, identified as a sub-statement or sub-item of the DOE text (such as done in this section) and begin with the bolded words "**At the WVDP:**" in the subsection item or statement.

   C. **At the WVDP:** The addition of site requirements following DOE RCS Article statements shall sequentially continue the Article numbering with the bolded words "**At the WVDP:**" in the item or statement following the DOE text, indicating the site-specific requirements.

2. Management policies, requirements, expectations, and objectives for the site radiological control program should be clearly and unambiguously stated.

3. The site-specific manual should be kept current and entered into the contractor document control system.

4. If a site has multiple facilities, there should be one manual for the site and one radiological control organization. If a prime contractor manages several DOE sites, efforts should be made to have one corporate radiological control manual that applies to all of that prime contractor's DOE sites. For a site that has multiple prime contractors, a common manual, with facility-, contractor-, or building-specific guidance to accommodate unique considerations, should be issued and endorsed by each contractor's senior site executive. For prime contractors who manage several sites but who also operate sites with more than one prime contractor, the site manual should take precedence over the corporate radiological control manual.

5. Subcontractors are not expected to develop their own radiological control manuals; rather they should comply with the site-specific radiological control manual.

6. Where DOE employees are conducting the transport of nuclear devices or components, a program-specific radiological control manual should be issued and approved by the DOE Operations Office Manager, the Service Center Manager, the DOE Project Office Manager or the DOE Site Manager, as appropriate. Controlled copies of such manuals should be provided to the Secretarial Officer having primary responsibility for operations at the site.

7. **At the WVDP:** The WVDP RCM shall establish radiation protection practices consistent with the DOE RCS and approved radiation protection standards and promulgates West Valley Environmental Services (WVES) procedures for maintaining radiation exposure ALARA and within federally mandated exposure limits. The WVDP RCM, through implementation of 10 CFR 835, establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities [10 CFR 835.1(a)].

8. **At the WVDP:** The provisions of this manual do not apply to naturally occurring radioactive materials (NORM), unless specifically identified in the text. This applies to NORM which has not been concentrated or enhanced above levels found in the environment, and includes airborne radon and thoron progeny. NORM includes, but is not limited to, isotopes of potassium, uranium, thorium and their progeny. Requirements for NORM and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM - radioactivity which has been concentrated to levels above that found in the environment), are contained in Article 411.

9. **At the WVDP:** The provisions of the WVDP RCM do not apply to radioactive material contained in consumer products produced for and routinely accepted by the general public provided they are used for their intended purpose and the use does not alter the form or release of the radioactive materials. Any other use that could result in the release of the radioactive material from its licensed form requires appropriate radiological controls under the provisions of the WVDP RCM. Consumer product radioactive materials often have special handling and disposal procedures that must be noted and followed.

10. **At the WVDP:** Except as discussed in Article 114.11, the requirements in 10 CFR 835 do not apply to [**10 CFR 835.1(b)**]:

    A. Activities that are regulated through a license by the Nuclear Regulatory Commission or a State under an Agreement with the Nuclear Regulatory Commission, including activities certified by the Nuclear Regulatory Commission under section 1701 of the Atomic Energy Act;

    B. Activities conducted under the authority of the Director, Naval Nuclear Propulsion Program, as described in Public Law 98-525;

    C. Activities conducted under the Nuclear Explosives and Weapons Surety Program relating to the prevention of accidental or unauthorized nuclear detonations.

    D. Radioactive material transportation as defined in 10 CFR 835 and this manual;

    E. DOE activities conducted outside the United States on territory under the jurisdiction of a foreign government to the extent governed by occupational radiation protection requirements agreed to between the United States and the cognizant government; or

    F. Background radiation, radiation doses received as a patient for the purposes of medical diagnosis or therapy, or radiation doses received from participation as a subject in medical research programs.

11. **At the WVDP:** Occupational doses received as a result of excluded activities and radioactive material transportation, as listed in Articles 114.10.A through 114.10.E, shall be included to the extent practicable when determining compliance with the occupational dose limits at 10 CFR 835.202 (general employees) and 10 CFR 835.207 (minors), and with the limits for the embryo/fetus at 10 CFR 835.206 (see Table 2-1). Occupational doses resulting from authorized emergency exposures (see Appendix 2A) and planned special exposures (see Article 213) shall not be considered when determining compliance with the dose limits at 10 CFR 835.202 (general employees) and 10 CFR 835.207 (minors) [10 CFR 835.1(c)].

115 Application of Provisions

1. This Standard assumes that most facilities or sites have organizations in place that generally meet the provisions presented in the text. It is not the intent of this Standard to unnecessarily create new or separate organizations if those functions can be incorporated into existing ones. Existing organizational and committee charters should be revised to reflect the provisions and emphasis of this Standard. Similarly, titles such as “radiological control manager” and “radiological control technician” that are used in the Standard may locally be designated differently. Position descriptions and organizational charts should be revised to accurately reflect required radiological control responsibilities.

   A. **At the WVDP:** The title of Radiological Control Manager is designated as Radiation Safety Manager.

2. The degree of program formality and extent of the associated administrative process should be commensurate with the extent of existing and potential radiological hazards. For example, a site with an annual collective total effective dose of one person-rem or less, that works with small quantities of unsealed radioactive material, would not be expected to have a radiological control program as complex as one required at higher hazard sites. At lower hazard sites, some program elements may be satisfied by brief policy statements.

116 User Groups

1. DOE encourages its contractors to establish informal working associations that promote dialogue among the radiological control organizations from similar or comparable facilities. User Groups should include representation from various contractors.

2. To assist contractors in identifying and adopting proven practices and implementing procedures in a timely manner within the DOE complex, DOE encourages its contractors to develop, through the User Groups, Radiological Work Practices Handbooks that can be used by a given category or class of facilities associated with the User Group.

117 The "As Low As Is Reasonably Achievable" Process

10 CFR 835 requires DOE activities to develop and implement plans and measures to maintain occupational radiation exposures as low as is reasonably achievable (ALARA) [see 10 CFR 835.101 and 835.1001]. As applied to occupational radiation exposure, the ALARA process does not require that exposures to radiological hazards be minimized without further consideration, but that such exposures be optimized, taking into account both the benefits arising out of the activity and the detriments arising from the resultant radiation exposures and the controls to be implemented.

An effective ALARA process includes effective consideration, planning, and implementation of both engineered controls and administrative controls to balance the risks of occupational radiation exposure against the benefits arising out of the authorized activity. Lessons learned are documented, institutionalized, and considered in planning and executing subsequent activities to further the goals of the ALARA process and to provide optimal employee protection.

While most or all of the provisions of this Standard support the ALARA process, the provisions of Chapter 3 are specifically directed toward the planning and execution of work, physical design features and administrative controls, and efforts to implement work controls commensurate with the radiological hazards.

118 Integrated Safety Management

DOE requires its contractors to develop and implement an Integrated Safety Management system (ISM) that integrates safety (including radiological safety) into management and work practices at all levels. (See DOE Policy 450.4 Safety Management System Policy and DOE Manual 450.4-1, Integrated Safety Management System, and associated guidance documents.). DOE intends for the provisions of this Standard to be consistent with, and to complement implementation of, ISM. This Standard supports ISM by providing a system of radiological controls that can be implemented on a site-wide basis and tailored to meet facility-and hazard-specific needs. This Standard also provides guidance for increasing worker involvement in identification and implementation of appropriate controls. Like the ALARA process, an effective integrated safety management system emphasizes the development and implementation of controls that are commensurate with the hazards associated with any specified activity.

1. Under ISM, both DOE and DOE-contractor line managers are charged with responsibility for integrating safety measures into all facets of work planning and execution. Line managers should use their site-specific radiological control manual as a guide to integrating radiological control measures into work planning and execution.

2. The DOE Radiological Control Standard supports the ISM guiding principles as follows:

   - Line Management Responsibility - The DOE Radiological Control Standard clearly indicates that line management is responsible for ensuring adequate implementation of the radiological control program.

   - Clear Roles and Responsibilities - The DOE Radiological Control Standard establishes clear roles and responsibilities for DOE and contractor line management and for the radiological control organization.

   - Competence Commensurate with Responsibilities - The DOE Radiological Control Standard provides guidance for providing classroom and on-the-job training so that individuals may gain and maintain the appropriate competence.

   - Identification of Safety Standards and Requirements - The DOE Radiological Control Standard provides cross-references to other DOE, Federal Agency, scientific, and consensus standards that are important to developing and implementing an effective and comprehensive radiological control program.

   - Hazard Controls Tailored to Work Being Performed - The DOE Radiological Control Standard provides guidance for implementing a program that establishes radiological controls that are commensurate with the hazards and that provide flexibility for consideration of other hazards (e.g., industrial safety, industrial hygiene, environmental hazards).

   The concepts of Balanced Priorities and Operations Authorization are outside the scope of the DOE Radiological Control Standard.

3. Both the ISM and ALARA processes require hazard controls to be tailored to the work being performed. In addition to establishing basic radiological safety standards that must be observed, 10 CFR 835 establishes requirements that provide significant flexibility so that individual activities may implement compliance measures in a manner that is commensurate with specific hazards and work activities. The DOE Radiological Control Standard provides guidance for implementing radiological controls that DOE has evaluated and found to meet the requirements of 10 CFR 835 and to be consistent with the specified conditions and activities. For example:

   - Chapter 3 of the DOE Radiological Control Standard provides guidance for implementing access and egress controls for areas having specific radiological conditions and hazards.

- Chapter 4 of the DOE Radiological Control Standard provides guidance for implementing specific controls over radioactive materials.

- Chapter 5 of the DOE Radiological Control Standard provides guidance for performing radiological monitoring at specified frequencies consistent with known and likely radiological hazards.

- Chapter 6 of the DOE Radiological Control Standard provides guidance for providing training to ensure that individuals are able to discharge their responsibilities related to the radiological control program.

119 10 CFR 851 Worker Safety and Health Program

On December 2, 2002, the 107th Congress amended the Atomic Energy Act by adding Section 234.C and on December 18, 2003, DOE published a Notice of Proposed Rulemaking in the Federal Register, entitled, "Worker Safety and Health Program." The Rule became final on February 9, 2006.

10 CFR 851 provides for a worker health and safety program for DOE contractors and should be addressed in hazard analysis evaluation for radiological operations.

PART 2. Leadership in Radiological Control

Superior, consistent performance is achieved when qualified individuals use approved procedures and management actively monitors the workplace and assesses ongoing activities. Such ongoing activities include, but are not limited to, operations, remediation, laboratory work, research and development, and cleanup. Constant review and informed interest by senior management are required to achieve a superior radiological control program. Management at all levels should emphasize the need for high standards for radiological control through direct communication, instruction, and inspection of the work space. The DOE Operations Office Manager and the contractor senior site executive responsible for the site should have a basic knowledge of radiation, its effects, and radiological control requirements. The DOE Operations Office Manager and the contractor senior site executive should also be familiar with the current radiological control performance record. Key principles common in a successful, well-managed radiological control program are provided in this Chapter.

121 Senior Management Commitment

1. Senior managers should establish high standards for radiological control performance and frequently communicate these standards and management expectations to the work force.

2. Senior managers should state in writing their firm commitment to a high-quality radiological control program.. Management commitment and support should be demonstrated, in part, by allocating sufficient resources, including personnel, and providing for training to ensure workers are qualified for their assigned duties.

3. Managers should ensure that orientation, training, and indoctrination reinforce rules and guidelines for each worker to control radiation exposure and radiological conditions.

4. Managers should hold workers and their supervisors accountable for radiological control performance. Relevant knowledge and performance should be assessed as a specific part of each individual's performance evaluation. This assessment should not be limited to those who perform radiological work, since many other workers have an impact on the radiological control program.

5. Senior managers should solicit feedback from their radiological control professionals, line management, and workers on radiological control performance.

6. Senior managers should encourage initiatives to identify concerns at an early stage, to prevent conditions from deteriorating, and to promote doing the right job correctly the first time.

7. Prevention of the spread of radioactive material is usually less costly than remediation. Management should accept change that will improve radiological control performance.

8. The authority and responsibility to establish a comprehensive and effective radiological control training program should be assigned to line managers and their subordinates. Training, in most cases, should be provided by a dedicated training organization, but the responsibility for quality and effectiveness rests with line management.

9. Senior managers should encourage minimizing the generation of radioactive waste and discharges to the environment, controlling contamination at its source, and minimizing radiation dose to workers and the public.

10. The manager is responsible for fixing or mitigating a radiological problem, regardless of whether it has been reported to a superior (contractor or DOE).

11. **At the WVDP:** Senior management personnel responsible for operations involving handling or processing of radioactive materials shall be knowledgeable of the contents of the WVDP RCM (see Article 651). Implementation of operating standards shall be the responsibility of line management.

122 Worker Attitude

Control of worker radiation exposure can be achieved only if all individuals involved in radiological activities have an understanding of and the proper respect for radiological hazards.

1. Each worker should understand that proper radiological control is an integral part of his/her daily duties.

2. The training program should support a positive attitude in the work force. Training instructors should be knowledgeable about the work environment and those aspects of radiological control that are important to developing a positive worker attitude and perspective.

3. Cooperation between the work force and the radiological control organization should be developed and fostered.

4. Radiological control organization personnel should be helpful in showing workers how to follow the rules. This spirit of cooperation should be developed without subverting the control functions of the radiological control technicians.

5. A situation in which radiological controls are left solely to the radiological control organization is unacceptable.

123 Worker Responsibilities

The following radiological controls should be included in training, as appropriate to the type of work conducted at the site. Management should consider displaying a poster that outlines basic worker responsibilities, such as those listed below, at appropriate access points and work areas.

TO CONTROL YOUR RADIATION EXPOSURE AND RADIOACTIVE MATERIAL,
OBSERVE THE FOLLOWING RULES:

OBEY

- Posted, written, and oral radiological control instructions and procedures, including instructions on radiological work permits.
- "Evacuate" and "stop work" orders from radiological control personnel promptly.

DO NOT

- Loiter in radiation areas.
- Smoke, eat, drink, or chew in contamination areas, high contamination areas, and airborne radioactivity areas.

BE SURE TO
- Wear personnel monitoring devices where required by radiological work permits, signs, procedures, or by radiological control personnel. Report immediately the loss, damage, or unexpected exposure of personnel monitoring devices or off-scale readings of self-reading dosimeters to the radiological control organization.
- Keep track of your radiation exposure status and avoid exceeding radiological administrative control levels.
- Wear personal protective equipment and clothing properly whenever required by radiological work permits or postings.
- Minimize the spread of potential radioactive spills and promptly notify the appropriate personnel of all spills.
- Avoid contact of skin, clothing, and equipment with contaminated surfaces.
- Place contaminated tools, equipment, and solid waste items on disposable surfaces, such as plastic sheets, when not in use.
- Notify radiological control personnel of alarming or faulty radiological control equipment.
- Notify radiological control personnel of off-site occupational radiation exposures so that worker dosimetry records can be updated.
- Notify radiological control personnel of any medical use of radioactive material, which could interfere with personnel contamination controls.

PRIOR TO ENTERING AREA
- Assure that you are mentally alert and in physically sound condition.
- Limit the amount of material taken into contaminated areas to minimize radioactive waste and future decontamination.
- Have necessary materials and equipment on hand to complete your task, thereby minimizing time and exposure.
- Notify radiological control personnel of the presence of open wounds, sores or rashes before entering an area where contamination exists and exit immediately if a wound occurs while in such an area.

UPON LEAVING AREA
- Properly remove personal protective equipment and clothing to minimize the spread of contamination.
- Frisk or be frisked for contamination when entering an uncontaminated area after exiting contamination, high contamination, or airborne radioactivity areas and associated radiological buffer areas and notify radiological control personnel when contamination is found.

124 Radiation and Risk Communications

The following radiological controls should be included in training, as appropriate to the type of work conducted at the site. Management should consider displaying a poster that outlines basic worker responsibilities, such as those listed below, at appropriate access points and work areas.

1. Appropriate training in accordance with Article 651 is helpful in dealing with workers who have anxiety about radiation.

2. Some individuals, such as those who have had internal depositions of radionuclides, may be concerned about future doses. Counseling with such individuals is the preferred way to consider relevant factors. In some cases, special control levels as described in Article 216 might be appropriate.

125 Conduct of Radiological Operations

1. The DOE Radiological Control Standard is consistent with the provisions of DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities. The concepts of all chapters of DOE Order 5480.19 apply to the conduct of radiological control activities.

2. Managers should ensure adequate radiological safety is not compromised to achieve production, remediation, or research objectives.

3. Supervisors enhance their effectiveness by being be technically knowledgeable and inquisitive and asking questions of the work force concerning radiological work details to verify worker comprehension.

4. Line managers should periodically monitor work areas to observe personnel at work and to identify good radiological work practices and radiological deficiencies and concerns. Frequent inspections and walk-throughs, including off-hours and weekends (where appropriate), reinforce management expectations to the work force.

5. Written procedures for performing radiological work should be clear and accurate. If during the use of procedures a written requirement cannot be responsibly followed, the worker should be stopped and guidance obtained.

6. Supervisors and managers should encourage the workers to identify radiological control deficiencies and concerns, and should take prompt appropriate action to address identified issues and prevent recurrence. Training, indoctrination, and procedure review are useful in addressing these issues.

7. Managers and supervisors should establish working conditions that enhance radiological control. This includes temperature, humidity, and lighting as well as the more difficult considerations of accessibility. Work conditions should be considered in planning work.

8. Cleanliness and good housekeeping are essential to a robust radiological control program. Workers should routinely clean up after operations.

9. Subcontractors and subcontracted employees should be treated the same as facility staff in the area of radiological control matters, shall have comparable radiation safety training [see 835.901], and should meet the same requirements and expectations.

10. Conditions that could cause or promote the spread of contamination, such as a leaking roof or piping, should be identified and corrected on a priority basis.

126 Worker Awareness of Radiological Conditions

In performing assigned duties within radiological areas, workers should be familiar with the area radiological conditions and be aware of the possibility that unforeseen changes may occur. Although the conduct of radiological surveys is viewed as a traditional role of radiological control technicians, properly trained and qualified workers should perform supplemental radiological surveys in the course of work thus potentially reducing radiological exposure and improving contamination control.

Specific examples of surveys that may be effectively performed by workers and result in exposure reductions include self-monitoring of dose rates during high radiation area entries and monitoring of tools and equipment for contamination as a qualitative check during work in contamination areas. The performance of legal record surveys, such as release surveys, should remain the responsibility of the radiological control organization.

127 Critiques

It is DOE's desire and expectation, based on concern for the safety and well-being of workers and the general public, that radiological work practices be continually scrutinized and questioned so that opportunities for improvement can be identified, assessed, and applied.

A formal critique process should be established to obtain pertinent facts following an unusual radiological situation or at the satisfactory conclusion of a new or unusual operation involving radiological controls. This process complements the Occurrence Reporting and Processing System (ORPS) of DOE O 231.1A, Environment, Safety and Health Reporting. The process, as described in Article 351, is used to quickly establish facts in chronological order so that the underlying reasons or causes for the success or failure are well understood.

An informal critique process can be established for less severe occurrences.

128 Facility Modifications and Radiological Design Considerations

Radiological control performance is affected by human performance and engineered design features. This Standard primarily addresses the way individuals operate and use existing facilities and sites. General design criteria for new facilities and major modifications to existing facilities are provided in 10 CFR 835 and DOE O 420.1B, Facility Safety. Additional design criteria are provided in Chapter 3.

PART 3. Improving Radiological Control Performance

131 Radiological Performance Goals

1. Collective Dose (person-rem): This goal should be based upon planned activities and historical performance.

2. Skin and Personal Clothing Contamination Occurrences (number): Personnel contaminations may indicate a breakdown of controls intended to prevent the spread of contamination.

3. Intakes of Radioactive Material (number): Management should focus attention on any failure of the controls that results in unplanned intakes.

4. Contaminated Area within Buildings (square feet): Operating with a smaller contaminated area may result in less radioactive waste, fewer personnel contaminations, and improved productivity. The reduction of existing contaminated areas should be balanced by the recognition that this generates radioactive waste. Goals for both should be correlated.

5. Radioactive Waste (cubic feet): Minimizing the generation of radioactive waste reduces the environmental impact of DOE operations, helps reduce personnel exposure, and reduces costs associated with handling, packaging, and disposal.

6. Liquid and Airborne Radioactivity Released (curies): Minimizing effluents reduces the environmental impact of DOE operations and reduces the costs associated with remediation.

132 Management of Radiological Control Goals and Performance Indicators

1. The contractor senior management should establish, approve, and maintain a radiological control goals and performance indicator program.

2. The radiological control goals should be measurable, achievable, auditable, and meaningful in promoting a sound radiological control program.

3. Radiological control goals should be reviewed at least annually and revised as appropriate.

133 Radiological Control Performance Reports

1. The radiological control manager or designee should provide a periodic summary report to the contractor senior management for sites which exceed an annual collective dose of one person-rem. This report should include feedback on the radiological control goals established in accordance with Article 131. Examples of performance indicators that provide a more detailed analysis of performance are identified in Table 1-1. The periodic report should provide current performance indicators, as well as tracking and trending for the prior twelve-month period.

   A. **At the WVDP:** Summary reports containing radiological performance goals per Article 131 and radiological indicators identified in Table 1-1 should be prepared in accordance with WV-984. *[Article 113]*

   B. **At the WVDP:** The Regulatory Affairs Department shall provide a summary report that includes the amount of liquid and airborne radioactivity released to the environment (see Article 131.6) to the WVES Project Manager per WVDP-098 [*Article 113*].

   C. **At the WVDP:** The Regulatory Affairs / Waste Management organizations shall provide a summary report that includes the cubic feet of radioactive waste generated (see Article 131.5) to the WVES Project Manager per WVDP-087 [*Article 113]*.

   D. **At the WVDP:** The Radiation Safety Manager shall assign a value for the "maximum area of contaminated areas within buildings" as a radiological performance goal (see Article 131.4) instead of a reduction goal [*Article 113*].

2. The radiological control manager should provide appropriate performance indicator information to supervisors and managers on a frequent enough basis to permit management of radiological control performance. The frequency should be consistent with the nature of the workload and the potential for not achieving the established goals.

3. To promote worker awareness of radiological control performance, supervisors should consider placing in the workplace selected indicators related to their work group should be posted in the workplace.

Table 1-1. Suggested Radiological Control Performance Indicators

Exposure control	
a.	Collective dose in person-rem
b.	Average worker dose in rem
c.	Maximum dose to a worker in rem
d.	Number of unplanned exposures resulting in doses greater than the facility administrative control level
e.	Number of dose assessments for lost or damaged dosimeters
Personnel contamination	
a.	Number of skin and personal clothing contaminations
b.	Number of contaminated wounds
c.	Number of facial contaminations
Control of internal exposure	
a.	Number of unplanned intakes
b.	Number of airborne events
c.	Number of alarms on airborne monitors (actual and false)
d.	Number of airborne radioactivity areas
e.	Area of airborne radioactivity areas in square feet
Control of contaminated areas in operational areas	
a.	Number of contamination and high contamination areas
b.	Area of contamination areas in square feet
c.	Area of high contamination areas in square feet
d.	Number of spills requiring posting of an area
Minimization of radioactive waste	
a.	Volume and activity of radioactive waste in cubic feet and curies, respectively
b.	Number of cubic feet not subject to volume reduction by incineration, compaction, or other means
Control of radioactive discharges	
a.	Activity of liquid radioactivity discharges in curies
b.	Activity of airborne radioactivity discharges in curies

134 Assessments

Assessment, as used in this Standard, refers to the process of providing independent feedback to senior line managers to indicate the adequacy of the radiological control program.

1. Inspections, audits, reviews, investigations, and self-assessments are part of the numerous checks and balances needed in a good radiological control program. Internal audits of the radiation protection program shall be conducted such that over a 36-month period, all functional elements are assessed [see 835.102]. The audits should address program performance, applicability, content, and implementation. These audits should be performed by the radiological control organization, the quality assurance organization, or other organizations having the requisite knowledge to adequately assess radiological control activities.

2. Identification of the functional elements of the program depends upon many site- or specific factors. Based upon the contents of 10 CFR 835, the following functional elements should be considered for inclusion in the assessment program:

   - Personnel dosimetry and dose assessment
   - Portable and fixed instrumentation
   - Contamination control
   - Radiological monitoring (area and item monitoring)
   - ALARA program
   - Accident and emergency dose controls
   - Radioactive material control, including sealed radioactive source control and material release
   - Entry controls
   - Training
   - Posting and labeling
   - Records and reports
   - Radiological design and administrative controls

3. Results of assessments should be incorporated into the ongoing process of improving radiological control performance.

4. Managers should encourage the positive view that identifying even minor deficiencies represents an opportunity for further improvement. The number of deficiencies does not in itself measure the overall quality of the radiological control program. A prioritization system to implement actions for resolving the deficiencies should be implemented.

5. In developing corrective action plans for assessment activities, managers should address root causes for the identified deficiencies or concerns, not just the specific symptoms identified by the reviewer.

6. Feedback on findings from assessments, root-cause analyses, status of corrective actions, and adherence to action plan schedules should periodically be provided to management.

7. **At the WVDP:** The time interval to conduct internal audits per 10 CFR 835.102 may be extended by a period not to exceed 30 days to accommodate scheduling needs [**10 CFR 835.3(e)**].

135 Workplace Awareness

1. DOE encourages management initiatives to facilitate the expression of concerns on the part of the work force, to address such concerns, and to solve them to ensure the proper respect for and understanding of radiation.

2. Management should establish and support a radiological awareness reporting system. To enhance work force awareness, the program should encourage continuous evaluation and improvements, track resolution of concerns, provide feedback to employees, and post results and trends. This system may be integrated with similar reporting systems for non-radiological concerns.

136 Internal Exposures

Control and prevention of internal exposure, particularly from long-lived radionuclides in the workplace, present special challenges to a radiological control program and warrant particular attention. Factors requiring management attention include the following:

- Workers may be exposed to unanticipated levels of elevated airborne radioactivity. The time required to collect representative airborne radioactivity samples and to determine the airborne concentration of radionuclides may contribute to worker intakes of radioactivity.
- If controls fail, internal depositions of radionuclides can occur in a short period of time.
- The continued exposure of workers to airborne radioactivity over extended periods of time can create worker concerns.
- Doses from some radionuclides taken into the body are difficult to measure. Although some radionuclides, such as cesium and tritium, can be readily measured at levels that produce only a few millirem, some long-lived radionuclides, such as plutonium, may require years for accurate measurements of hundreds of millirem.
- Medical intervention, such as the administration of blocking and chelating agents, to mitigate internal deposition may add risks by introducing additional chemicals into the body.
- Sampling of body excretions and whole body or organ counting techniques may encourage worker perceptions of internal exposure significance.
- Administration of internal dose assessment is costly in dollars and worker time. Control and analysis of samples are also more complicated and time consuming than the elements of external dosimetry.
- Use of respiratory protection devices imposes additional physical stresses upon participating workers.
- Overall optimization of total dose – sum of both external and internal.

The hierarchy of controls required to control internal exposures is provided in Article 316.

137 Neutron Exposures

Neutron exposures have the following characteristics that require attention:

- The specific biological effects of neutrons vary with energy.
- Neutron dose is more difficult to measure than gamma dose.

138 ALARA Committee

The ALARA process of managing radiation exposures is a fundamental requirement of every radiological control program. An ALARA Committee provides a useful forum for reviewing radiological control plans and performance and focusing management resources on radiological control issues. The goal of the ALARA Committee should be to promote the optimization of personnel exposure to workers and the public.

1. An ALARA Committee should be established. The membership should include managers and workers from the line, the technical support organization, and the radiological control organization. It is more effective if a line manager, such as Director of Operations, Research, or Maintenance serves as the Chair. This Committee may be part of a general safety or radiation safety committee whose functions include ALARA activities and possibly be combined with other committees for smaller facilities.

2. The ALARA Committee should make recommendations to management to improve progress toward controlling radiation exposure and radioactive releases. The Committee should evaluate items such as construction and design of facilities and systems, planned major modifications or work activities, and experimental test plans for exposure, waste, and release controls. The Committee should also receive, as a minimum, the results of all radiological control program assessments, both internal and external, and should review the overall conduct of the radiological control program.

    A. **At the WVDP:** Radiological Control program assessment results (both internal and external) shall be forwarded to the ALARA Committee Chairperson, rather than all members of the ALARA Committee. Only Radiation Protection Functional Area Element (FAE) assessment results shall be forwarded to the ALARA Committee Chairperson per the Article 138.2 requirement for review. Results from all external Radiological Control program assessments shall be distributed to the ALARA Committee Chairperson *[Article 113]*. DOE external assessments that focus on an individual functional area element, such as personnel dosimetry, do not need to be forwarded to the ALARA Committee chairperson. DOE external assessments that cover several functional area elements that are part of an overall radiological control program assessment, such as those included in a revolving 3 year review, are expected to be forwarded to the ALARA Committee Chairperson.

PART 4. Contractor Radiological Control Organization

141 Radiological Control Organization

1. A radiological control organization should be established to provide relevant support to line managers and workers. To function effectively, the radiological control organization should be independent of the line organizational element responsible for production, operation, or research activities and should have an equivalent reporting level. A single, dedicated radiological control organization for the site is sufficient. At larger DOE sites where facilities, buildings, or work areas are dispersed, an approach that provides site-wide consistency and individual facility radiological control support is recommended. The senior line manager responsible for operations at a facility should have assigned radiological control personnel dedicated to the facility. Consistency of radiological control is critical. It is not the intent of this Standard to duplicate organizations but to use personnel in an effective manner in workplace situations.

2. Radiological control personnel should monitor adherence to 10 CFR 835 requirements and to the site-specific radiological control standard and be available to the facility line manager for radiological support to the work force. To function effectively in this capacity, they should receive their day-to-day priorities from facility managers. To ensure independence in making correct radiological control decisions, the radiological control organization should be accountable to the radiological control manager.

3. The radiological control manager heads the radiological control organization and is responsible for and should establish a high quality radiological control program.

4. The radiological control manager should have access to the contractor senior management for radiological control matters.

5. **At the WVDP:** Other responsibilities include:

   A. WVES Project Manager - is responsible for approving the WVDP RCM and ensuring it's implementation by senior management. The WVES Project Manager should have a basic knowledge of radiation, it's effects, and radiological control requirements per Chapter 1, Part 2, and should be familiar with the current radiological performance record. The WVES Project Manager is assisted by the Environmental, Safety, Health, and Quality Manager.

   B. Environmental, Safety, Health & Quality (ESH&Q) Manager -is responsible for overall management of WVES safety functions including radiological control. The ESH&Q Manager is assisted by the Radiation Safety Manager, and reports to the WVES Project Manager.

   C. Regulatory Affairs (RA) Manager - is responsible for conducting environmental radiation surveillance and effluent monitoring program for evaluating radiation exposures to members of the general public and ensuring that public doses from operations and activities conducted at the WVDP are maintained within the limits established by DOE. The RA Manager shall assist operating management in developing programs and plans for maintaining radiation exposures to members of the public ALARA, regularly monitoring routine and non-routine releases, and assessing doses to members of the public as required by DOE and other legally applicable regulations (such as EPA's NESHAP requirements under 40 CFR 61). The RA Manager reports to the WVES Project Manager.

   D. Radiation Safety (RS) Manager - is responsible for monitoring the Radiological Control Program for WVDP site personnel and visitors, assisting operating management in developing programs and plans for maintaining radiation exposures ALARA, maintaining radiological safety of the site by regularly evaluating and assessing surface contamination, radiation levels, and airborne radioactivity concentrations in the work areas. The RS Manager reports to the Environmental, Safety, Health & Quality Manager. The RS Manager and staff have the primary role in the

implementation and coordination of the WVDP Radiological Control Program. The RS Manager is assisted by the:

1. Radiological Engineering, and the Dosimetry Program staff.

2. Radiation Safety Supervisors, Radiological Control Technicians, and the RS Instrument Lab staff.

E. Radiation Safety organization staff - are responsible for developing programs to ensure that radioactive wastes are properly stored, processed, and handled so as to minimize radiation exposure to employees and visitors, maintaining radiation exposures to individuals ALARA, providing programs for personnel and area dosimetry, and for developing and maintaining the WVDP RCM. Radiation Safety organization staff shall provide support to management in implementing the radiological protection program. It is the responsibility of the RS Manager and staff to cease operations in the event that operating conditions are not in compliance with operational safety controls or approved operating procedures.

6. **At the WVDP:** The Radiation Safety Manager and staff have the authority to remove from the list of employees authorized to receive occupational radiation exposure those individuals who approach the established administrative control levels. Individuals who have not demonstrated their continuing understanding of, or the need for compliance with, radiological safety related operating procedures, should also be subject to revocation of their radiological worker qualification by the Radiation Safety Manager and/or Radiation Safety organization staff.

7. **At the WVDP:** Radiological Control Technicians are the on-the-job representatives of the Radiation Safety organization. As such, they are responsible for identifying radiological safety hazards and ensuring that work is not allowed to proceed without abatement or control of these hazards. To implement this responsibility, Radiological Control Technicians have the authority to stop any work that violates the applicable work procedures or that, in their opinion, presents an imminent danger of:

A. Excessive radiation exposure to personnel;

B. Contamination of personnel or the environment; or

C. Personnel injury or equipment damage.

Unless precluded by the urgency of the situation, cessation of operations should be implemented through the operating supervisor who is responsible for the overall conduct of the job. If there is a disagreement between the responsible supervisor and the Radiological Control Technician, the work should be safely suspended. Any disagreement should subsequently be resolved by the responsible manager, in conjunction with the Radiation Safety Supervisor and/or the Radiation Safety Manager.

142 Radiological Control Manager Qualifications

1. The radiological control manager should be an experienced radiological control professional and be familiar with the design features and operations of the facility that affect radiological hazards.

2. The radiological control manager should have the technical competence and experience to establish radiological control programs and the supervisory capability to direct the implementation and maintenance of radiological control programs.

3. The radiological control manager should have a minimum of a bachelor's degree or the equivalent in science or engineering, including some formal training in radiological control. Certification by the American Board of Health Physics provides equivalency to the above. The radiological control manager should have at least three years of professional experience in applied radiological control work. Advanced academic degrees can count as one year of experience where course work related to radiological control is involved. Radiological control manager qualifications should be consistent with the guidelines provided in DOE-STD-1107-1997, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.

4. If the most effective manager for this position does not satisfy the above qualifications, special arrangements should be made. In these situations, the assignment of a deputy with the requisite expertise and qualifications can satisfy the requirement. The education, training, and skills requirements of 10 CFR 835.103 would apply to both individuals to the extent that their responsibilities address programs to ensure compliance with 10 CFR 835.

5. Management should provide persons assigned to or being considered for the radiological control manager position a structured program leading to certification by the American Board of Health Physics.

143 Radiological Control Organization Functions and Staffing

1. The senior staff of the radiological control organization should include health physicists and other professionals with four-year degrees in science or engineering. A continuing training program should be established. DOE encourages pursuit of certification by the American Board of Health Physics for senior and professional staff members. Training and education provisions for these individuals are established in Article 654.

2. Radiological support personnel provide health physics and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation, and calibration functions. Training and education provisions for these individuals are established in Article 654.

3. Appropriate standards for the education and training of radiological control organization senior staff and support personnel are provided in DOE-STD-1107-1997, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.

144 Relationship Between Radiological Control Technicians and Workers

Radiological control technicians (RCTs) and their supervisors perform the functions of assisting and guiding workers in the radiological aspects of the job.

1. Radiological workers should be sufficiently trained to recognize questionable or deteriorating radiological conditions and seek advice from radiological control technicians and their supervisors.

2. RCTs and their supervisors have the responsibility and authority to stop work or mitigate the effect of an activity in accordance with Article 345.

3. The actions or presence of radiological control personnel does not absolve the workers of their responsibility for properly conducting radiological control aspects of the job.

145 Marginal Radiological Control Performance

1. When radiological control performance is less than adequate, consideration should be given to strengthening line management and the radiological control organization to provide adequate radiological control.

2. If the work force does not have the required level of sensitivity for radiological work practices, additional management attention is needed to assure the proper outcome. Line management should be held accountable for implementation of the radiological control program. Corrective actions that should be considered include:

   A. More direct line supervision in the work space

   B. Curtailment of work schedules

   C. Deferral of work

   D. Addition of extra radiological control personnel

   E. Conduct of additional training.

3. When radiological control performance is less than adequate, line management should consider the above corrective actions.

PART 5. DOE Management

151 Program Office

1. Secretarial Officers are responsible for the establishment and maintenance of radiological control programs for activities under their cognizance, and are accountable for the quality and performance of radiological work conducted at their assigned sites.

2. Each Secretarial Officer should designate an individual to be the Program Office focal point on radiological control matters with the DOE Operations Offices and applicable Field Organization Managers, counterparts within DOE, and the contractor organizations. This individual is referred to in this Standard as the Radiological Control Program Advisor.

152 Operations Offices and Applicable Field Offices

1. Managers of Operations Offices, Area Offices and Field Offices and NNSA Service Centers are responsible for the line management function of conducting day-to-day management of contractor activities, including monitoring the quality and performance of radiological work.

2. Managers of Operations Offices, Area Offices, and Field Offices and NNSA Service Centers should designate an individual to be responsible for providing radiological control program assessments, interacting routinely with the Radiological Control Program Advisors of the affected DOE Program Offices, assisting the DOE field line organization in the use of this Standard, and interacting on a periodic basis with counterparts at other sites.

153 Department Policy

The Office of Health, Safety and Security (HSS) is responsible for promulgating and maintaining the overall DOE policy and standards with respect to radiological health and safety. HSS is also responsible for periodically revising the Standard to make corrections or improvements to the document. Other DOE elements should rely upon subject matter experts within HSS for assistance on issues involving topics such as radiological health effects, health physics, dosimetry, instrumentation, training, and radiological controls.

154 Department Independent Radiological Control Performance Oversight

HSS carries out its responsibility to provide independent radiological control performance oversight, on behalf of the Secretary of Energy, through various means, including the following:

1. Uses 10 CFR 835 as its basis document. To the extent that a DOE activity's documented radiation protection program establishes commitments to the use of specific guidance documents, such as the 10 CFR 835 Guide (DOE G 441.1-1C), this Standard, or consensus standards, to achieve compliance, these documents should also be used as basis documents.

2. Assesses DOE Program, Operations, and applicable Field Office performance of their line management responsibilities for implementing and maintaining radiological controls as detailed in the basis document(s).

155 Radiological Control Coordinating Committee (RCCC)

1. The RCCC, as a minimum, consists of the Radiological Control Program Advisors from the Offices of the National Nuclear Security Administration, Science, Environmental Management, and Nuclear Energy, Science, and Technology, and representatives from HSS, and selected Operations Offices and Field Organizations.

2. The RCCC is expected to receive and review suggestions, concerns, and comments from its individual members, Operations Offices, and contractors. The RCCC functions in a collective manner to promote a consistent and uniform emphasis in the direction and implementation of this Standard. Communications with the RCCC should follow standard administrative and reporting channels.

3. The RCCC should meet at least quarterly and more frequently during periods of transition (i.e., when developing or implementing significant new or revised complex-wide programs).

4. RCCC meetings should include representatives from Operations Offices and Field Organizations and recognized industry experts from outside DOE. The interaction with non-DOE professionals enhances the awareness of state-of-the-art technology and practices.

156 DOE Employees in the Workplace

DOE employees at a DOE site or facility are subject to and should adhere to the provisions of the contractor's site-specific radiological control standard.

CHAPTER 2 RADIOLOGICAL STANDARDS
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PART 1. Administrative Control Levels and Dose Limits

To accomplish DOE's objective of maintaining individual doses well below regulatory limits, challenging numerical administrative control levels should be established below the regulatory limits to administratively control and help minimize individual and collective radiation dose. These control levels should be multi-tiered with increasing levels of authority required to approve higher administrative control levels.

Unless otherwise indicated, administrative, lifetime, and special control levels and dose limits are stated in terms of the total effective dose, which is the sum of the doses received from internal and external sources.

211 Administrative Control Level

1. Facility management should establish an annual facility administrative control level based upon an evaluation of historical and projected radiation exposures, work load, and mission. This control level should be reevaluated annually. The choice of a low level for one year does not preclude choosing either a higher or lower level in a subsequent year. The facility administrative control level should be approved by the contractor senior site management.

2. When there is wide variation in the expected doses to the various work groups at a single facility, facility management should develop work group-specific administrative control levels to control worker doses below the regulatory limits.

    A. **At the WVDP:** The established administrative control level should be reevaluated annually.

    B. **At the WVDP:** If the evaluation results in a change to the annual administrative control level, the WVDP RCM should be revised or changed to reflect the new level.

3. No individual should be allowed to exceed the facility administrative control level without the prior written approval of the radiological control organization and cognizant facility management. Authorization by the contractor senior management is recommended.

    A. **At the WVDP:** An annual Administrative Control Level of 500 mrem Total Effective Dose (TED) resulting from DOE activities, other than planned special exposures per Article 213.2,a and emergency exposures per Article 213.2.a and Appendix 2A, for WVDP employees and subcontractors shall be maintained, unless approved per Article 211.3.

    B. **At the WVDP:** WVDP employees and subcontractors who have received radiological doses at non-DOE facilities prior to working at the WVDP and who may potentially exceed or have exceeded 500 mrem per year TED may be allowed to receive additional radiological dose at the WVDP with written approval by the Radiation Safety Manager. While working at the WVDP, these WVDP employees and subcontractors should not exceed the WVDP annual Administrative Control Level from work performed at the WVDP facility.

    C. **At the WVDP:** WVDP employees and subcontractors who have received radiological doses at other DOE facilities prior to working at the WVDP and who may potentially exceed or have exceeded 500 mrem per year TED may be allowed to receive additional radiological dose at the WVDP, not exceeding 1,500 mrem per year TED and with written approval by the Radiation Safety Manager. While working at the WVDP, these WVDP employees and subcontractors should not exceed the WVDP annual Administrative Control Level from work performed at the WVDP facility.

4. **At the WVDP:** The following Administrative Control Levels, which are below the DOE Administrative Control Levels, shall be used as one method to maintain personnel radiation doses ALARA. Activities for workers at the WVDP shall not cause the DOE Administrative Control Levels to be exceeded as a result of DOE activities for assessed doses specified herein and summarized in Table 2-1, except as noted in Articles 211.3, 211.4 and Appendix 2A.

   A. Except as approved in Articles 211.4.C and 211.4.D below, the limiting value for the Total Effective Dose received by radiological workers and general employees is 500 mrem per year and 100 mrem per day. The limiting values of deep equivalent dose and for external exposures and the committed equivalent dose received by radiological workers and general employees are:

      - 5,000 mrem per year and 1,000 mrem per day to any organ or tissue, extremities of the body, and to the skin of the whole body;
      - 1,500 mrem per year and 300 mrem per day to the lens of the eye.

   B. Limiting values for the Total Effective Dose for all occupationally exposed minors, visitors, and the general public during direct onsite access at the WVDP shall not exceed 100 mrem per year. Similarly, the limiting values of deep equivalent dose for external exposures and the committed equivalent dose is:

      - 500 mrem to any organ or tissue, the extremities of the body, and to the skin of the whole body; and
      - 150 mrem to the lens of the eye.

   C. Prior to any individual exceeding the WVDP Administrative Control Levels in Articles 211.4A, 211.4B, or 211.4D, written approval shall be obtained from the following individuals:

      1. The Cognizant Manager
      2. The Cognizant Staff Manager
      3. The Radiation Safety Manager

      Prior to exceeding the **annual** WVDP Administrative Control Levels, the written approval of the WVES Project Manager shall be obtained in addition to those mentioned above (see Article 211.4). A copy of the written approval for exceeding the control levels shall be included in the individual's permanent exposure history file.

   D. An exception to Article 211.4A above is applied to personnel performing “hands-on” radiological work (e.g., RCTs, D&D Operators, Plant Systems Operators, Waste Processing Operators, etc.) who are approved to have an Administrative Control Level (ACL) of 1,000 mrem per year Total Effective Dose (TED). These personnel are issued TLDs with the QD identifier. Any worker may be approved for an extension of their ACL up to a maximum of 1,500 mrem per year, on an individual basis, pending review and approval by the WVES Project Manager. See WV-984 for the Radiation Dose Action Level Notification / Evaluation Review Process.

5. **At the WVDP:** Exposures above the annual or daily WVDP Administrative Control Levels, without prior written approval, shall be evaluated in accordance with WVDP-242. When the exposure status of an employee becomes uncertain or an exposure control is likely to have been exceeded, that individual shall be restricted from entering radiologically posted areas until the exposure has been determined and documented.

212 Lifetime Control Level

1. Efforts should be made to control each individual's lifetime occupational dose below a lifetime control level of N rem where N is the age of the individual in years. Article 216 discusses special control levels for radiological workers who have doses exceeding N rem. This is applicable only to radiological workers because they are the only individuals expected to receive greater than 100 mrem in a year; see Article 721 for supporting information.

2. To ensure compliance with the lifetime control level, efforts should be made to determine the lifetime occupational dose of individuals expected to receive more than 1 rem in a year. The lifetime occupational dose is determined by summing all occupational internal and external doses received during the individual's lifetime.

   A. **At the WVDP:** To control a worker's lifetime occupational exposure to N rem, the WVDP local control levels are established at less than 1.0 rem per year, and in most cases, much less than 1.0 rem per year. For individuals whose work will require more than 1.0 rem during a year, a review of the lifetime exposure estimate should be made with the employee to verify it's completeness.

   B. **At the WVDP:** Any correction to the off-site data, such as best estimates for periods when records have not been or cannot be obtained, that are consistent with known records and approved by the employee, will be made to keep the best estimate of lifetime exposure. Internal exposures should be included in the lifetime dose. Administrative Control Levels are established in accordance with Article 211.

3. The internal contribution to lifetime occupational dose from intakes prior to January 1, 1989, may be calculated in terms of either cumulative annual effective dose or committed effective dose equivalent. The committed effective dose equivalent should be used to the extent that adequate data are available to calculate doses in these terms.

213 Occupational Dose Limits

Protection and Operational Quantities

The ICRP Publication 60 dosimetric quantities adopted in 10 CFR 835 have been designated by ICRP as “protection quantities” that are intended for defining and calculating the numerical limits and action levels used in radiation protection standards such as 10 CFR 835. Protection quantities provide a way to relate the magnitude of a radiation exposure to the risk of a health effect that is applicable to an individual and that is largely independent of the type and source (internal or external) of the radiation. In addition the protection quantities can be easily calculated for use in planning radiological work.

These goals are achieved using a combination of theoretical and practical considerations. For example, absorbed dose is assumed to be averaged over a tissue or organ. Radiation weighting factors are used to account for the biological effectiveness of various types and energies of radiation and tissue weighting factors are used to account for the sensitivity of various tissues to radiation induced cancer. See Appendices F and G of Chapter 16 of this Guide for listings of values. The tissue and radiation weighting factors are based on both biological and epidemiological studies and have been updated as new research became available. Nevertheless, the values of these weighting factors are approximations that account for both uncertainty in the underlying data and the need to ensure that the protection quantities do not underestimate the true dose and hence the risk. Protection quantities used in 10 CFR 835 include: equivalent dose, effective dose, committed equivalent dose, committed effective dose, total effective dose, and cumulative total effective dose.

Because protection quantities were developed to provide an index of the risk resulting from energy imparted to tissue by radiation, they are theoretical and not measurable. Fortunately, it is possible to use the measurable properties of radiation fields and radioactive materials associated with exposure to external radiation sources or intake of radioactive materials to estimate and demonstrate compliance with the protection quantities. These measurable quantities are called operational quantities.

Although many types of operational quantities are possible, a well characterized set of operational quantities for assessing doses received from external exposure have been selected by the International Commission on Radiation Units and Measurements (ICRU) in Report 51, *Quantities and Units in Radiation Protection Dosimetry*. These operational quantities have been adopted in recommendations of the ICRP and in the standards implementing the ICRP recommendations written by the International Atomic Energy Agency (IAEA) and the European Union (EU). In addition, the ICRP, in Publication 74, *Conversion Coefficients for Use in Radiological Protection against External Radiation*, compared and contrasted doses determined using the ICRP system of protection quantities with doses determined using the ICRU based operational quantities. For almost all situations considered, doses determined with the operational quantities were greater or equal to the doses determined using protection quantities. These operational quantities and their relation to the protection quantities listed in the June 8, 2007 version of 10 CFR 835 are listed below.

Relation between protection quantities and operational quantities for individual monitoring of external exposure

Protection quantity	Operational quantity (depth [d] in tissue [mm])
Equivalent dose to the whole body from external sources*	$H_p(10)$
Equivalent dose to the lens of the eye from external sources	$H_p(3)$
Equivalent dose to the extremity or skin from external sources	$H_p(0.07)$

Where $H_p(d)$ is the personal equivalent dose at depth d in tissue
See ICRU Report 51 for the definition of $H_p(d)$
* Same as effective dose from external sources.

For doses resulting from intakes of radioactive materials operational quantities have been published in ICRP, IAEA and EU documents.

Relation between protection quantities and operational quantities for individual monitoring of doses from intakes of radioactive material

Protection quantity	Operational quantity
Committed effective dose	$\sum_j h_{j,eff,50,inh} I_{j,inh} + \sum_j h_{j,eff,50,ing} I_{j,ing}$
Committed equivalent dose	$\sum_j h_{j,T,50,inh} I_{j,inh} + \sum_j h_{j,T,50,ing} I_{j,ing}$

Where: $h_{j,eff,50,inh}$ is the committed effective dose per unit of radioactivity intake by inhalation (*inh*)
$h_{j,eff,50,ing}$ is the committed effective dose per unit of radioactivity intake by ingestion (*ing*)
$h_{j,T,50,inh}$ is the committed equivalent dose to a tissue (T) per unit of radioactivity intake by inhalation
$h_{j,T,50,ing}$ is the committed equivalent dose to a tissue (T) per unit of radioactivity intake by ingestion
$I_{j,inh}$ is an intake by inhalation
$I_{j,ing}$ is an intake by ingestion
j is a radionuclide

For the total effective dose, the following operational quantity is suggested.

Protection quantity	Operational quantity
Total effective dose	$H_p(10) + \sum_j h_{j,eff,50,inh} I_{j,inh} + \sum_j h_{j,eff,50,ing} I_{j,ing}$

In addition to the operational quantities used for individual monitoring, the following table contains operational quantities that may be measured to characterize certain aspects of radiation fields in the workplace.

Operational quantities for use in characterizing workplace radiation fields

Workplace measurement	Suggested operational quantity
Control of effective dose	*H*(10)*
Control of dose to the skin, the extremities and the lens of the eye	*H'(0.07, Ω)*
Control of dose to the lens of the eye	*H'(3, Ω)*

Where: *H*(10)* is the ambient equivalent dose at a depth of 10 mm in tissue
H'(0.007, Ω) is the directional equivalent dose at a depth of 0.07mm in the ICRU sphere
H'(3, Ω) is the directional equivalent dose at a depth of 3 mm in the ICRU sphere
Ω defines the direction of the radiation field
See ICRU Report 51 for the definitions of ambient equivalent dose and directional equivalent dose

In the 2007 amendment to 10 CFR 835, DOE deleted the terms deep dose and shallow dose. The following was added to the definition of equivalent dose: “For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue.”

The 10 CFR 835 definition of “absorbed dose” is taken from ICRP Publication 71, which reads:

Absorbed Dose: the physical dose quantity, which is given by:

dE/*dm*

where dE is the mean energy imparted by ionizing radiation to the matter in a volume element and *dm* is the mass of the matter in this volume element. The SI unit for absorbed dose is joule per kilogram (J /kg) and its special name is gray (Gy).

The 10 CFR 835 definition:

Absorbed dose (D) means the average energy imparted by ionizing radiation to the matter in a volume element The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

While the 10 CFR 835 definition does not include the equation or the definition of the terms in the equation as does ICRP Publication 71, it does state that absorbed dose is expressed in units of rad, i.e., energy per mass (J/kg). Accordingly, for purposes of compliance, the 10 CFR 835 definition is considered equivalent to the ICRP Publication 71 definition.

1. Occupational dose limits are provided in Table 2-1 and shall not be exceeded [see 835.202(a)(1)-(4)]. All occupational dose received during the current year, including that received from accidents, except the dose resulting from planned special exposures and emergency exposures shall be included when demonstrating compliance with Table 2-1 limits [see 835.202(b) & 702(d)]. If formal records of an individual's prior occupational dose during the year cannot be obtained, a written estimate signed by the individual may be accepted [see 835.702(d)]. Written estimates should not be used as a basis for authorizing planned special exposures or emergency exposures.

2. In an exceptional situation, a radiological worker may be authorized to receive a dose in excess of the values of the limits specified in Table 2-1.

   A. Planned special exposures may be authorized for an individual to receive doses in addition to and accounted for separately from doses received under the Table 2-1 limits [see 10 CFR 835.204].

NOTE ***At the WVDP:*** *See Article 213.5 for additional 10 CFR 835 requirements on Planned Special Exposures.*

   B. Under emergency conditions, individuals may be authorized to receive doses that exceed the limits established in Table 2-1 [see 835.1301 & 1302]. The provisions of this Standard are not intended to limit actions necessary to protect health and safety under these conditions [see 10 CFR 835.3(d)].

DOE believes that there are few situations in which conduct of a planned special exposure or emergency exposure will constitute a best management practice and that proper implementation of the provisions of this Standard will obviate the need for conducting these operations. Therefore, specific guidance for conduct of these operations is not provided in this Standard. Requirements for authorizing, conducting, recording, and reporting these operations are provided in 10 CFR 835 and, for emergency exposures, in DOE Emergency Management Guides, DOE G 151.1-4, Sections 7.4.3 and 7.4.4.

3. The occupational dose limits provided in Table 2-1 apply to all general employees. However, general employees who have not completed appropriate training and examinations are not permitted unescorted access to any radiological area [see 10 CFR 835.901(b)].

4. **At the WVDP:** The total effective dose during a year shall be determined by summing the effective dose from external exposures and the committed effective dose from intakes during the year. [**10 CFR 835.203(a)**].

5. **At the WVDP:** Requirements for Planned Special Exposures are as follow:

   A. A planned special exposure may be authorized for a radiological worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in 10 CFR 835.202(a), provided that each of the following conditions is satisfied [**10 CFR 835.204(a)**]:

      1. The planned special exposure is considered only in an exceptional situation when alternatives that might prevent a radiological worker from exceeding the limits in 10 CFR 835.202(a) are unavailable or impractical;

      2. WVES management (and employer, if the employer is not the contractor) specifically requests the planned special exposure, in writing; and

      3. Joint written approval is received from the appropriate DOE Headquarters program office and the Secretarial Officer responsible for environment, safety and health matters.

B. Prior to requesting an individual to participate in an authorized planned special exposure, the individual's dose from all previous planned special exposures and all doses in excess of the occupational dose limits shall be determined [**10 CFR 835.204(b)**].

C. An individual shall not receive a planned special exposure that, in addition to the doses determined in 10 CFR 835.204(b), would result in a dose exceeding the following [**10 CFR 835.204(c)**]:

1. In a year, the numerical values of the dose limits established at 10 CFR 835.202(a); and

2. Over the individual's lifetime, five times the numerical values of the dose limits established at 10 CFR 835.202(a).

D. Prior to a planned special exposure, written consent shall be obtained from each individual involved. Each such written consent shall include [**10 CFR 835.204(d)**]:

1. The purpose of the planned operations and procedures to be used;

2. The estimated doses and associated potential risks and specific radiological conditions and other hazards which might be involved in performing the task; and

3. Instructions on the measures to be taken to keep the dose ALARA considering other risks that may be present.

E. Records of the conduct of a planned special exposure shall be maintained and a written report submitted within 30 days after the planned special exposure to the approving organizations identified in 10 CFR 835.204(a)(3) [**10 CFR 835.204(e)**].

F. The dose from planned special exposures is not to be considered in controlling future occupational dose of the individual under 10 CFR 835.202(a), but is to be included in records and reports required under 10 CFR 835 [**10 CFR 835.204(f)**].

214 Member of the Public Dose Limit

Members of the public permitted access to the controlled area at DOE sites shall be limited to an annual radiation dose of 100 millirem from the sum of doses received from internal and external radiation sources [see 10 CFR 835.208].

215 Embryo/Fetus Dose Controls

After a female worker voluntarily notifies her employer in writing that she is pregnant, for the purposes of fetal/embryo protection, she is considered a declared pregnant worker. This declaration may be revoked, in writing, at any time by the declared pregnant worker [see 10 CFR 835.2(a), Declared pregnant worker].

1. The employer should provide the option of a mutually agreeable assignment of work tasks, without loss of pay or promotional opportunity, such that further occupational radiation exposure during the remainder of the gestation period is unlikely.

2. For a declared pregnant worker who chooses to continue work involving occupational exposure:

A. The dose limit for the embryo/fetus from conception to birth (entire gestation period) as a result of the occupational exposure of the declared pregnant worker is 500 millirem [see 10 CFR 835.206(a)]. The dose to the embryo/fetus is equal to the sum of doses received from external doses, sources inside the mother, and sources inside the embryo/fetus. The dose limit to the fetus is the equivalent dose.

B. Measures shall be taken to avoid substantial variation above the uniform exposure rate necessary to meet the 500 millirem limit for the gestation period [see 10 CFR 835.206(b)]. Efforts should be made to avoid exceeding 50 millirem per month to the declared pregnant worker.

C. **At the WVDP:** Upon notification, the worker's dosimetry badge should be exchanged and processed to determine exposure from conception to notification date, when appropriate.

3. If the dose to the embryo/fetus is determined to have already exceeded 500 millirem when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks where additional occupational radiation exposure is likely during the remainder of the gestation period [see 10 CFR 835.206(c)].

4. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C, "Radiation Protection Programs Guide."

5. **At the WVDP:** Female employees shall be instructed on the Department of Energy and the National Council on Radiation Protection and Measurement's recommendations to keep radiation exposure to an embryo/fetus to the very lowest practicable level during the entire gestation period. This instruction shall be provided in the General Employee Radiological Training (GERT) portion of the WVDP General Employee Training (GET).

6. **At the WVDP:** It is the responsibility of the female worker to notify her supervisor/manager and Employee Health Services personnel when she suspects, or knows, that she is pregnant. Employee Health Services personnel shall then notify dosimetry office personnel. If the worker is qualified to use respiratory equipment, that qualification should be revoked during the remainder of the gestation period.

7. **At the WVDP:** The dosimetry office shall maintain a female dose tracking system to maintain an awareness of female radiological workers with higher accumulated doses approaching the embryo/fetus dose limits.

Table 2-1 Summary of Occupational Dose Limits

TYPE OF EXPOSURE	LIMIT
General Employee: Whole Body (internal + external) (TED)	5 rem/year
General Employee: Lens of the Eye (external)	15 rem/year
General Employee: Skin and extremities (external shallow dose plus internal dose resulting in dose to the skin)	50 rem/year
General Employee: Any organ or tissue (other than lens of eye) (internal + external)	50 rem/year
Declared Pregnant Worker: Embryo/Fetus (internal + external)	0.5 rem/ gestation period
Minors: Whole Body (internal + external) (TED)	0.1 rem/year
Minors: Lens of the eye, skin, and extremities	10% of General Employee limits

Notes:

1. The weighting factors in Appendix 2C shall be used in converting organ equivalent dose to effective dose for the whole body dose [see 835.203(b)].
2. The annual limit of dose to "any organ or tissue" is based on the committed equivalent dose to that organ or tissue resulting from internally deposited radionuclides over a 50-year period after intake plus any equivalent dose to that organ from external exposures during the year[see 835.202(a)(2)].
3. Exposures due to background radiation, as a patient undergoing therapeutic and diagnostic medical procedures, and participation as a subject in medical research programs shall not be included in either personnel radiation dose records or assessment of dose against the limits in this Table [see 835.202(c)].
4. See Appendix 2D for guidance on non-uniform exposure of the skin.
5. Whole body dose (total effective dose [TED]) = effective dose from external exposures + committed effective dose from internal exposures [see 835.2(a)].
6. Lens of the eye equivalent dose = equivalent dose from external exposure determined at a tissue depth of 0.3 cm [see 835.2(a)].
7. Equivalent dose from external exposure determined at a tissue depth of 0.007 cm [see 835.2(a)].

216 Special Control Levels

Certain situations may require lower individual exposure control levels. In addition to considering recommendations from senior radiological control and medical officials, the contractor senior site executive should obtain advice from professionals in other disciplines such as human resources and legal in establishing special control levels. The contractor senior site executive may wish to establish these special control levels using a radiological health advisory group.

1. A special control level for annual occupational exposure should be offered to each radiological worker with a lifetime occupational dose exceeding N rem, where N is the age of the individual in years. The special control level should allow the individual's lifetime occupational dose to approach and, if practicable, fall below N rem during ensuing years as additional occupational dose is received.

2. An employer should be attentive to special circumstances of employees, such as those undergoing radiation therapy, and offer to establish special control levels, at the employee’s discretion, as appropriate.

3. Special controls on an individual dose should not be implemented in a manner that interferes with that individual's right to work. If reasonable efforts to implement the special control level below 1 rem per year threaten to restrict the individual's right to work or are otherwise unsuccessful, the contractor senior site executive should authorize any doses in excess of the special control level, but not to exceed the regulatory dose limits.

4. **At the WVDP:** Personnel undergoing radiation therapy or treatment involving internal intakes of medical isotopes should inform their supervisor or Radiation Safety organization personnel in advance of the treatment or upon return to work. The Radiation Safety organization should determine what Special Controls should be appropriate. Selection of Special Controls in the case of internal intakes of medical isotopes should consider the Article 511 requirement that primary dosimetry not be exposed to medical sources of radiation, and the potential interference with the Article 338 requirements for monitoring for personnel contamination.

PART 2. Contamination Control and Control Levels

Control of radioactive contamination is achieved by using engineering controls and worker performance to contain contamination at the source, reducing existing areas of contamination, and promptly decontaminating areas that become contaminated.

At the WVDP: Appropriate controls shall be maintained and verified which prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions [**10 CFR 835.1102(a)**].

221 Personnel Contamination Control

1. Article 338 provides personnel contamination monitoring requirements and guidance. This guidance is not relevant to individuals exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.

2. Monitoring for contamination should be performed using frisking equipment that can detect total contamination at or below the values specified in Table 2-2. DOE encourages the use of automatic monitoring units that meet the above requirements.

3. Individuals found with detectable contamination on their skin or personal clothing, other than noble gases or natural background radioactivity, should be promptly decontaminated as described in Article 541.

222 Contamination Control Levels

1. A surface is considered contaminated if either the removable or total surface contamination is detected above the levels in Table 2-2. Controls shall be implemented for these surfaces commensurate with the nature of the contaminant and level of contamination [see 10 CFR 835.1102(b)]. Appropriate postings and controls are established in Chapters 2, 3, and 4 of this Standard.

2. Surfaces exceeding the values of Table 2-2 for total contamination may be covered with a fixative coating to prevent the spread of contamination. However, reasonable efforts should be made to decontaminate an area before a coating is applied. A fixative coating should not be applied without the approval of the radiological control manager or designee.

   A. **At the WVDP:** Prior to sealing fixed and/or removable contamination, a survey should be performed that documents the location and levels of contamination involved.

   B. **At the WVDP:** Post-sealing surveys shall include external radiation exposure rates and removable contamination measurements of the sealed surfaces.

3. Appropriate controls for areas of fixed contamination are provided in Article 224.

4. For areas with contaminated soil that is not releasable in accordance with DOE's environmental protection standards, a soil contamination area should be established that:

   A. Is posted as specified in Article 238.

   B. Meets the requirements of Article 231.1 through 231.8.

5. Soil contamination areas may be located outside a radiologically controlled area (including a buffer area).

6. **At the WVDP:** All contamination areas shall be posted in accordance with the most restrictive conditions only. In addition to any contamination area posting, these areas may also require additional posting as

described in Articles 234, 236, and 237. Small enclosures, such as hoods, where removable or fixed contamination is present above the levels in Table 2-2 require posting as appropriate. See Article 347 for additional controls.

7. **At the WVDP:** Areas or items that are below the unrestricted release limits of Table 2-2 should be released from control by the Radiation Safety organization. Formerly contaminated areas or items that are presently below the levels in Table 2-2 may be released from control at the discretion of the Radiation Safety organization using the ALARA philosophy and after considering other factors such as the potential for the area or item becoming contaminated again, spread of contamination from adjacent areas, or future use of the item in contaminated areas.

223 Airborne Radioactivity Control Levels

1. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing individuals, with or without respiratory protection, to enter airborne radioactivity areas.

2. Posting requirements for airborne radioactivity areas are specified in Article 235. Values of Derived Air Concentrations are provided in 10 CFR 835.

3. **At the WVDP:** The derived air concentration (DAC) values given in appendices A and C of 10 CFR 835 shall be used in the control of occupational exposures to airborne radioactive material [see 10 CFR 835.209(a)].

224 Areas of Fixed Contamination

Due to reduced concerns regarding contamination spread, areas having only fixed contamination may not warrant the full range of entry controls established for areas having removable contamination levels exceeding the Table 2-2 values. Areas located outside of radiological areas having measured total contamination exceeding the total surface contamination values specified in Table 2-2 (removable contamination levels below Table 2-2 values) are subject to the following controls:

1. Periodic surveys shall be conducted to ensure the surface contamination remains fixed to the surface and removable surface contamination levels remain below Table 2-2 values [see 10 CFR 835.1102(c)(1)].

2. Markings indicating the status of the area shall be applied [see 10 CFR 835.1102(c)(2)]. These markings should be applied directly to the surface (or at the access points) to provide appropriate warning. These markings may also provide appropriate instructions to individuals entering the area or contacting the surface (i.e., "Fixed Contamination" or "Fixed Contamination, Notify Radiological Control Personnel Prior to Removing Paint"). Signs, stencils, or other appropriate markings may be used.

3. Markings and postings should be maintained in a legible condition.

4. Appropriate written procedures should be implemented to prevent unplanned or uncontrolled removal of the contamination. These procedures should address issues such as access controls and fixative coatings, if needed, survey techniques and frequency, area tracking and maintenance, and required markings.

5. If surveys indicate that contamination is likely to be transferred from the area, fixative coatings should be applied. When paint is used as a fixative coating, it should consist of two layers having contrasting colors, to provide indication of erosion of the top layer. Other fixative coatings, such as strippable coatings and applied plastics and foams, should be periodically evaluated for evidence of degradation. Removable contamination should be reduced to the minimum practicable level before application of fixative coatings.

   A. **At the WVDP:** Coverings applied should have yellow as the bottom coat and have a contrasting color as the top coat.

   B. **At the WVDP:** Those surfaces, whereby applying a yellow covering followed by a contrasting color as the top coat that would impede the proper operation of the equipment or component, do not require yellow as the bottom coat. However, the equipment or component must be identified as having fixed contamination [*Article 113*].

   C. **At the WVDP:** In the Main Plant, contrasting colors are not required for walls or ceilings [*Article 113*].

6. Areas meeting these requirements are exempt from the posting requirements of Articles 232 - 238 and the entry and exit requirements of Chapter 3.

7. **At the WVDP:** Fixed Contamination Areas are those areas which have total contamination levels (fixed + removable) greater than the levels specified in Table 2-2 (i.e., 500 dpm/100 cm^2 alpha and 5,000 dpm/100 cm^2 beta-gamma), but with removable contamination less than the limits specified in Table 2-2 (i.e., 20 dpm/100 cm^2 alpha and 200 dpm/100 cm^2 beta-gamma). Each Fixed Contamination Area must be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - FIXED CONTAMINATION." Exits from Fixed Contamination Areas do not require a personnel survey except when specified by the Radiation Safety organization.

Table 2-2 Summary of Surface Contamination Values
[see 10 CFR 835, Appendix D and
DOE Order 5400.5, Figure IV-1]

The data presented in this table from 10 CFR 835, Appendix D, are to be used in identifying and posting contamination and high contamination areas in accordance with 10 CFR 835.603(e) and (f) and identifying the need for surface contamination monitoring and control in accordance with 10 CFR 835.1101 and 1102.

Surface Contamination Values[1] in dpm/100 cm^2

Radionuclide	Removable [2,4]	Total (Fixed + Removable)[2,3]
U-nat, U-235, U-238, and associated decay products	[7] 1,000	[7] 5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5]	1,000	5,000
Tritium and STCs [6]	10,000	See Footnote 6

[1] The values in this appendix, with the exception noted in footnote 6 below, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides apply independently.

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

[3] The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.

[4] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[5] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
[6] Tritium contamination including special tritium compounds (STCs) may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "Total" value does not apply. In certain cases, a "Total" value of 10,000 dpm/100 cm^2 may be applicable either to metals of the types from which insoluble special tritium compounds are formed, that have been exposed to tritium, or to bulk materials to which insoluble special tritium compound particles are fixed to a surface.
[7] These limits apply only to the alpha emitters within the respective decay series.

At the WVDP: The predominant alpha emitting and beta emitting radionuclides in radioactive contamination at the WVDP, taking into consideration their respective limits, are transuranics (including Pu-239 and Am-241) and fission products (including Sr-90 and Cs-137), respectively. When the radioisotopic mixture is unknown and available data results are expressed in gross alpha activity or gross beta-gamma activity, the following limits for transuranics (including Pu-239 and Am-241) and fission products (including Sr-90 and Cs-137) shall apply, respectively:

Gross alpha (removable): 20 dpm/100 cm^2 removable contamination.

Gross alpha (total):

Posting and restricted release to the Controlled Area without leaving the WVDP Controlled Area (per Article 421): 500 dpm/100 cm^2 total (fixed plus removable) contamination averaged over one square meter and 1,500 dpm/100 cm^2 maximum in any 100 cm^2 area.

Release to the Controlled Area and (potentially) leaving the WVDP Controlled Area (per Article 422) as an unrestricted release: 100 dpm/100 cm^2 total (fixed plus removable) contamination averaged over one square meter and 300 dpm/100 cm^2 maximum in any 100 cm^2 area.

Gross beta-gamma (removable): 200 dpm/100 cm^2 removable contamination.

Gross beta-gamma (total):

Where the Sr-90 fraction is **50 percent or less**, the mixed fission product surface activity values of 5,000 dpm/100 cm^2 total (fixed plus removable) contamination averaged over one square meter and 15,000 dpm/100 cm^2 maximum in any 100 cm^2 area.

Where the Sr-90 fraction is **between 50 percent and 90 percent** of the total activity, the surface radioactivity values of 3,000 dpm/100 cm^2 total (fixed plus removable) contamination averaged over one square meter and 9,000 dpm/100 cm^2 maximum in any 100 cm^2 area.

Where the Sr-90 fraction **exceeds 90 percent** of the total activity, the surface radioactivity values of 1,000 dpm/100 cm^2 total (fixed plus removable) contamination averaged over one square meter and 3,000 dpm/100 cm^2 maximum in any 100 cm^2 area.

Notes:

1. **At the WVDP:** For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value [see 10 CFR 835, App. D, note 3].

2. At the WVDP: Unrestricted release criteria per DOE Order 5400.5, Figure IV-1.

PART 3. Posting

231 General Posting Provisions

1. Radiological postings are intended to alert individuals to the presence of radiation and radioactive materials and to aid them in controlling exposures and preventing the spread of contamination. Boundaries used for radiological control purposes are depicted in Figure 2-1.

2. Signs shall contain the standard radiation symbol (radiation warning trefoil) colored magenta or black on a yellow background [see 10 CFR 835.601(a)]. Lettering should be either magenta or black. Magenta is the preferred color. Standardized signs, as described in DOE's core training and the 10 CFR 835 Guide, should be used where practicable.

   A. **At the WVDP:** Warning signs or tags other than those approved for use by this manual shall be approved in writing by the Radiation Safety Manager. All radiation symbols used on radiological signs and tags shall conform with ANSI N2.1 or N12.1.

   B. **At the WVDP:** Radiological signs shall not be used for any purpose other than radiological controls.

3. Signs shall be conspicuously posted at each access point [see 835.601, 603], clearly worded, and, where appropriate, may include radiological control instructions [see 835.601(b)]. Radiological postings should be displayed only to signify actual or potential radiological conditions. Signs used for training should be clearly marked, such as "For Training Purposes Only."

4. Posted areas should be as small as practicable for efficiency.

5. Postings should be maintained in a legible condition and updated based upon the results of the most recent surveys.

6. If more than one radiological condition (such as contamination and high radiation) exists in the same area, each condition shall be identified [see 835.603].

7. In areas of ongoing work activities, the dose rate and contamination level or range of each should be included on or in conjunction with each posting as applicable.

   A. **At the WVDP:** The dose rate (for radiation areas) and contamination level (for contamination areas) or range should be included on the Radiation Work Permit and posted at the jobsite per Article 322. In areas with routine work covered by standard operating procedures (or equivalent), the dose rate level and/or range should be posted on the radiation area signs and documented on routine survey maps, while contamination levels and/or ranges are documented on routine survey maps [*Article 113*].

8. Postings at entrance points to areas of ongoing work activities controlled for radiological purposes should state basic entry requirements, such as dosimetry, radiological work permit (RWP) or other written authorization, and respiratory protection requirements.

9. Rope, tape, chain, and similar barriers used to designate the boundaries of posted areas should be distinctive (e.g., yellow and magenta or yellow and black in color).

   A. **At the WVDP:** The boundaries of radiological areas, if not a permanent wall or fence, shall be clearly indicated by rope or chain.

B. **At the WVDP:** Outdoor radiological areas should be bounded by at least signs and where practical, by ropes or chains. Fences should be used whenever possible. Warning signs should be posted at all anticipated avenues of approach.

C. **At the WVDP:** In outside radiological areas, metal chains may be used instead of the plastic yellow chains. These areas shall be clearly posted per this manual to ensure that inadvertent entries do not occur and that radiological hazards are explicitly identified [*Article 113*].

10. Physical barriers should be placed so that they are clearly visible from all directions and at various elevations. They should not be easily walked over or under, except at identified access points. These barriers shall be set up such that they do not impede the intended use of emergency exits or evacuation routes [see 835.501(e), 502(d)].

11. Areas shall be clearly and conspicuously posted [see 835.601(b)]. Posting of doors should be such that the postings remain visible when doors are open or closed.

A. **At the WVDP:** In laboratories or other areas where walls form the boundary of radiological areas and doors are the only access to the areas, signs shall be posted for the greatest visibility for personnel entering the area; normally, at eye level on access doors or on the wall adjacent to the entrance door on the latch side.

12. A radiological posting that signifies the presence of an intermittent radiological condition should include a statement specifying when the radiation is present, such as "CAUTION: RADIATION AREA WHEN RED LIGHT IS ON."

13. Accessible areas may be excepted from the radiological area posting requirements:

A. During transient radiological conditions of less than 8 continuous hours duration when posting is not practical, such as radioactive material transfers. Under these conditions, the area shall be placed under the continuous observation and control of individuals who are knowledgeable of and empowered to implement required access and exposure control measures [see 835.604(a)]. These individuals should be stationed to provide line of sight surveillance and verbal warnings.

B. When the area contains only packages of radioactive material received from transportation while awaiting survey in accordance with Articles 552 and 554 [see 835.604(c)].

The exceptions discussed above apply only to radiological area and radioactive material area posting requirements and do not apply to the entry control requirements established in 10 CFR 835.501 and 835.502.

14. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C, "Radiation Protection Programs Guide."

15. **At the WVDP:** All radiological posting shall be done by or at the direction of the Radiation Safety organization. Movement or removal of posted warning signs, tags, or boundary markers by personnel other than Radiation Safety organization personnel, or without the approval of the Radiation Safety organization, should be cause for disciplinary action. Personnel should promptly report any posting deficiencies observed to the Radiation Safety organization.

16. **At the WVDP:** The posting and labeling requirements in 10 CFR 835 may be modified to reflect the special considerations of DOE activities conducted at private residences or businesses. Such modifications shall provide the same level of protection to individuals as the existing provisions in 10 CFR 835 [**10 CFR 835.601(c)**].

232 Posting Radiologically Controlled Areas

Radiologically controlled areas are established and posted to warn individuals that they are entering areas controlled for radiation protection purposes. Individuals who enter only the controlled area without entering radiological areas or radioactive material areas are not expected to receive a total effective dose exceeding 100 millirem in a year.

1. Each access point to a radiologically controlled area shall be posted whenever radiological areas or radioactive material areas may be present in the area [see 835.602(a)].

   A. **At the WVDP:** Each access point is defined as those points designed and designated by the WVDP for routine vehicle and pedestrian entries as described in approved site security procedures.

2. The contractor may select the type of sign used to avoid conflict with local security requirements [see 835.602(b)]. This selection should be approved by the contractor senior site executive.

3. **At the WVDP:** The security chain link fence establishes the Controlled Area. Each access gate to the site should be posted with signs with the wording "CONTROLLED AREA - TRAINING OR ESCORT REQUIRED FOR ENTRY."

4. **At the WVDP:** Restricted Access Areas have been established at the WVDP and are defined as areas which require special radiological precautions for entry.

   These areas are posted where there is a potential for changes in radiological conditions and it is determined by the Radiation Safety organization that those potential conditions be considered prior to entry.

   Entry into a Restricted Access Area shall require the approval of the Radiation Safety organization. Each Restricted Access Area must be designated by signs with the following words "CAUTION - RESTRICTED ACCESS - AREA - APPROVAL REQUIRED - FOR ENTRY - CONTACT RADIATION SAFETY." These signs should be yellow with black or magenta lettering.

233 Posting Radiological Buffer Areas

Radiological buffer areas are intended to provide boundaries to minimize the spread of contamination and to limit doses to general employees who have not been trained as radiological workers.

1. A radiological buffer area should be established for contamination control adjacent to any entrance to or exit from a contamination, high contamination, or airborne radioactivity area. The size of the radiological buffer area should be commensurate with the potential for the spread of contamination. A radiological buffer area may also be established in areas such as Change Rooms, where low-level contamination may be present, but where radioactive material handling is not specifically authorized.

2. A radiological buffer area should be established as needed for exposure control. The boundary for the radiological buffer area should be established to limit radiation doses (TED) to general employees to less than 100 millirem per year. The boundary for the radiological buffer area should be established to limit radiation doses (TED) to general employees to less than 100 millirem in a year or as needed to keep radiation doses to general employees ALARA.

3. A radiological buffer area is not warranted for:

   A. High contamination or airborne radioactivity areas that are completely within contamination areas

B. Inactive contamination, high contamination, or airborne radioactivity areas (i.e., areas to which entry has been prohibited by posting or barricades)

C. Exposure control, if other posted boundaries or controls provide equivalent employee protection

D. Exposure control, if general employees who are not trained as radiological workers are restricted from unescorted entry to controlled areas.

E. Exposure control, if general employees who are not trained as radiological workers are unlikely to be present in the area long enough to receive 100 mrem in a year.

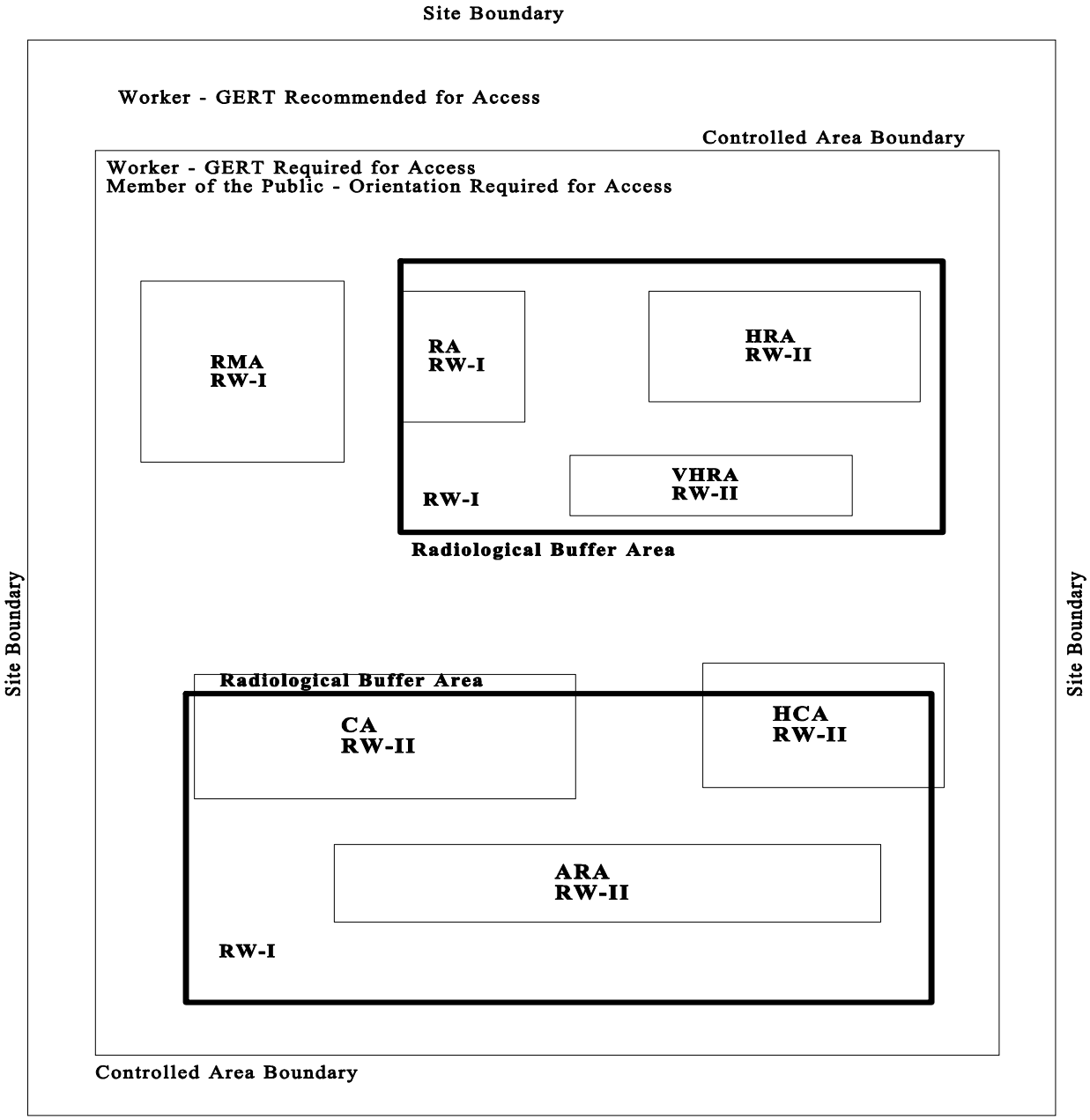
4. The need for radiological buffer areas around radioactive material areas, soil contamination areas, and underground radioactive material areas should be determined by the RCO based upon the potential for exposure of unmonitored individuals and the spread of contamination.

5. Posting of radiological buffer areas should be in accordance with Article 231 and contain the wording "CAUTION, RADIOLOGICAL BUFFER AREA."

A. **At the WVDP:** If a frisking location is at the exit of a Radiological Buffer Area, the exit should be posted.

Figure 2-1. Establishing Posted Areas

Figure 2-1
Establishing Posted Areas



GERT - General Employee Radiological TrainingHRA - High Radiation Area
RW-I - Radiological Worker IVHRA - Very High Radiation Area
RW-II - Radiological Worker IICA - Contamination Area
RMA - Radioactive Material AreaHCA - High Contamination Area
RA - Radiation AreaARA - Airborne Radioactivity Area

234 Posting Radiation Areas

1. Areas shall be posted to alert individuals to the presence of external radiation in accordance with Table 2-3 [see 835.601, 603]. In addition to the 'required posting' contractors may add supplemental information; examples of typical supplemental information are shown in Table 2-3. In addition, hot spots should be labeled as described below to provide warning of discrete radiation sources.

2. Radiation areas and high radiation areas shall be identified based on the dose rates at a distance of 30 centimeters either from the source or from any surface penetrated by the radiation [**see 10 CFR 835.2(a)**, radiation area and high radiation area]. Very high radiation areas shall be identified based on the dose rate at a distance of 100 centimeters either from the source or from any surface penetrated by the radiation [**see 10 CFR 835.2(a)**, very high radiation area].

3. Hot spots are localized sources of radiation, normally located within piping or components, with contact radiation levels greater than 100 millirem per hour (penetrating radiation dose) and more than 5 times greater than the general area dose rate. Contact readings should be used to determine the need for labeling hot spots. Measures taken to identify sources of elevated general area radiation levels while conducting routine radiation surveys should be sufficient to identify hot spot locations. Special surveys for the sole purpose of identifying hot spots are not required.

4. A label reading "Caution, Hot Spot" and marking the location of the hot spot should be placed on or as near the spot as practicable. The provisions of Article 231.7 through 231.11 do not apply to the hot spot labeling. Labeling of hot spots is not required in areas with general area dose rates greater than 1 rem/hr. However, the locations of such hot spots should be noted on area surveys and discussed in pre-job briefings.

5. Dose received in an hour may be used as the criterion for posting (Column 2 of Table 2-3). At very high doses received at high dose rates (such as doses received in a very high radiation area), dose rates should be measured and recorded in units of "rads" rather than "rem" in an hour.

Table 2-3. Criteria for Posting Radiation Areas

AREA	CRITERIA	REQUIRED POSTING	SUPPLEMENTAL POSTING
Radiation Area	Radiation levels could result in an individual receiving > 0.005 rem in 1 hour at 30 cm	"CAUTION, RADIATION AREA" [see 835.603(a)]	"RWP AND PERSONNEL DOSIMETER REQUIRED FOR ENTRY"
High Radiation Area	Radiation levels could result in an individual receiving > 0.1 rem in 1 hour at 30 cm	"CAUTION" or "DANGER," "HIGH RADIATION AREA" [see 835.603(b)]	"PERSONNEL DOSIMETER, SUPPLEMENTAL DOSIMETER, AND RWP REQUIRED FOR ENTRY"*
Very High Radiation Area	Radiation levels could result in an individual receiving > 500 rad in 1 hour at 100 cm	"GRAVE DANGER, VERY HIGH RADIATION AREA" [see 835.603(c)]	"SPECIAL CONTROLS REQUIRED FOR ENTRY"*

* Access requirements may be deleted or modified if personnel access is specifically prohibited.

235 Posting Contamination, High Contamination, and Airborne Radioactivity Areas

1. Areas shall be posted to alert individuals to the presence (or likely presence) of surface contamination and airborne radioactivity in accordance with Table 2-4 [see 835.603].

2. Derived Air Concentration (DAC) values found in 10 CFR 835 shall be used in posting airborne radioactivity areas in accordance with Table 2-4 [see 835.209(a)].

3. **At the WVDP:** Contamination Areas are those areas, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Table 2-2 (i.e., 20 dpm/100 cm^2 alpha and 200 dpm/100 cm^2 beta-gamma), but do not exceed 100 times those values [10 CFR 835.2(a)]. Each Contamination Area must be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - CONTAMINATION AREA" [**10 CFR 835.603(e)**].

4. **At the WVDP:** High Contamination Areas are those areas, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Table 2-2 [10 CFR 835.2(a)]. Each High Contamination Area must be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - HIGH CONTAMINATION AREA" or "DANGER - HIGH CONTAMINATION AREA" and the words "RWP REQUIRED FOR ENTRY" [**10 CFR 835.603(f)**].

5. **At the WVDP:** Airborne Radioactivity Areas are those areas, accessible to individuals where the concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the Derived Air Concentrations (DAC) in 10 CFR 835 Appendix A, or, an individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week [**10 CFR 835.2(a)**]. Each Airborne Radioactivity Area shall be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVE AREA" and the words "RWP REQUIRED FOR ENTRY" [**10 CFR 835.603(d)**].

Table 2-4. Criteria for Posting Contamination, High Contamination, and Airborne Radioactivity Areas

AREA	CRITERIA	REQUIRED POSTING	SUPPLEMENTAL POSTING
Contamination Area	Removable contamination levels (dpm/100 cm^2) > Table 2-2 values[1] but ≤ 100 x Table 2-2 values	"CAUTION, CONTAMINATION AREA" [see 835.603(e)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
High Contamination Area	Removable contamination levels (dpm/100 cm^2) > 100 x Table 2-2 values[1]	"CAUTION" or "DANGER," "HIGH CONTAMINATION AREA" [see 835.603(f)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
Airborne Radioactivity Area	Airborne concentrations (µCi/ml) above background: 1) are > the applicable DAC values[1]; or 2) could result in an individual (w/o respirator) receiving an intake > 12 DAC-hrs in a week	"CAUTION" or "DANGER," AIRBORNE RADIOACTIVITY AREA" [see 835.603(d)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"

[1] Levels exceed or are likely to exceed the listed values

236 Posting Radioactive Material Areas

1. Accessible areas where items or containers of radioactive material in quantities exceeding the values provided in Appendix E of 10 CFR 835 are used, handled, or stored shall be posted "CAUTION or DANGER, RADIOACTIVE MATERIAL" [see 835.603(g)].

   A. **At the WVDP:** Any Naturally Occurring Radioactive Material (NORM) having a dose rate of 50 microrem/hour or greater on any accessible surface, shall be stored in a Radioactive Material Area.

2. Radioactive material areas shall be within a controlled area [see 835.(2)(a), radioactive material area].

3. Radioactive material areas may be excepted from the posting requirements when:

   A. The area is posted as a radiological area in accordance with Article 234 or 235 [see 835.604(b)(1)]; or

   B. Each item or container of radioactive material in the area is clearly labeled to warn individuals of the hazards [see 835.604(b)(2)]; or

   C. The radioactive material of concern consists solely of structures or installed components which have been activated (such as by exposure to neutron radiation or particles produced in an accelerator); or

   D. The area contains only packages of radioactive material received from radioactive material transportation while awaiting monitoring in accordance with Articles 552 and 554 [see 835.604(c)]; or

E. For periods of eight continuous hours or less, the area is under the continuous observation and control of an individual knowledgeable of, and empowered to implement, required access and exposure control measures [see 835.604(a)].

4. Provisions for labeling radioactive material are specified in Chapter 4.

5. **At the WVDP:** Exits from Radioactive Material Areas do not require a personnel survey except when specified by the Radiation Safety organization.

237 Posting Underground Radioactive Material Areas

1. Underground radioactive material areas should be established to indicate the presence of underground items that contain radioactive materials, such as pipelines, radioactive cribs, covered ponds, covered ditches, catch tanks, inactive burial grounds, and sites of known, covered, unplanned releases (spills). Underground radioactive material areas need not be posted if physical or administrative controls are implemented to ensure appropriate radiological controls are established prior to excavating, penetrating, or otherwise disturbing underground radioactive materials.

A. **At the WVDP:** Surface materials are defined as those within the top six inches of the ground, while subsurface materials are those greater than six inches below the ground surface.

2. Underground radioactive material areas should be posted "UNDERGROUND RADIOACTIVE MATERIAL." Posting should include instructions or special warnings to workers such as "Consult Radiological Control Organization before Digging" or "Subsurface Contamination Exists." The posting should meet the applicable requirements of Article 231.

3. Underground radioactive material areas may be located outside controlled areas unless access is likely to result in individual doses (total effective dose) greater than 100 millirem in a year from underground radioactive material.

4. Underground radioactive material areas are exempt from the entry and exit requirements of Chapter 3 when access is not likely to result in individual doses greater than 100 millirem in a year. Article 333.1 provides entry provisions for instances in which access is likely to result in individual doses greater than 100 millirem in a year.

238 Posting Soil Contamination Areas

1. For areas with contaminated soil that is not releasable in accordance with DOE's environmental protection standards, a soil contamination area should be established that is posted in accordance with the requirements in Article 231.1 through 231.8. Posting should include the words "Caution, Soil Contamination Area" and instructions or special warnings to workers, such as "Consult with Radiological Control Organization before Digging" or "Subsurface Contamination Exists."

A. **At the WVDP:** Soil Contamination Areas are those areas accessible to individuals where soil contamination is known to exist or is likely to exist in concentrations above natural soil background greater than 20 dpm/g alpha or 100 dpm/g beta-gamma. Surface materials are defined as those within the top six inches of the ground, while subsurface materials are those greater than six inches below the ground surface.

B. **At the WVDP:** No soil material should be released offsite from the WVDP for unrestricted use unless approved by DOE in accordance with DOE Order 5400.5 or under the provisions under Article 422.

C. **At the WVDP:** Each Soil Contamination Area shall be posted with signs meeting the appropriate standard and including the radiation symbol, and the words "CAUTION - SOIL

CONTAMINATION AREA." Exits from Soil Contamination do not require a personnel survey except when specified by the Radiation Safety organization.

D. **At the WVDP:** Soil Contamination Area signs shall include the words "RWP Required for Excavation."

2. Soil contamination areas may be located outside controlled areas if exposure to the material in the area is not likely to cause any individual to receive a total effective dose in excess of 100 millirem in a year.

3. If the contamination levels in the area exceed the values provided in Table 2-2 (as evidenced by the likelihood of tracking contamination out of the area at levels exceeding these values), then the area is a contamination area or high contamination area and shall be posted in accordance with Article 235 [see 835.2(a), contamination area and high contamination area and 835.603(d) and (e)].

Appendix 2A. Reserved

Appendix 2B. RADIATION WEIGHTING FACTORS[1], w_R

Type and energy range	Radiation weighting factor
Photons, electrons and muons, all energies	1
Neutrons, energy < 10 keV[2, 3]	5
Neutrons, energy 10 keV to 100 keV[2, 3]	10
Neutrons, energy > 100 keV to 2 MeV[2, 3]	20
Neutrons, energy > 2 MeV to 20 MeV[2, 3]	10
Neutrons, energy > 20 MeV[2, 3]	5
Protons, other than recoil protons, energy > 2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

1. All values relate to the radiation incident on the body or, for internal sources, emitted from the source.
2. When spectral data are insufficient to identify the energy of the neutrons, a radiation weighting factor of 20 shall be used.
3. When spectral data are sufficient to identify the energy of the neutrons, the following equation may be used to determine a neutron radiation weighting factor value:

$$w_R = 5 + 17 \exp\left[\frac{-(\ln(2E_n))^2}{6}\right]$$ Where E_n is the neutron energy in MeV.

Appendix 2C

TISSUE WEIGHTING FACTORS FOR VARIOUS ORGANS AND TISSUES

Organs or tissues, T	Tissue weighting Factor, w_T
Gonads	0.20
Red bone marrow	0.12
Colon	0.12
Lungs	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Esophagus	0.05
Thyroid	0.05
Skin	0.01
Bone surfaces	0.01
Remainder[1]	0.05
Whole body[2]	1.00

Notes:

[1] "Remainder" means the following additional tissues and organs and their masses, in grams, following parenthetically: adrenals (14), brain (1400), extrathoracic airways (15), small intestine (640), kidneys (310), muscle (28,000), pancreas (100), spleen (180), thymus (20), and uterus (80). The equivalent dose to the remainder tissues ($H_{remainder}$), is normally calculated as the mass-weighted mean dose to the preceding ten organs and tissues. In those cases in which the most highly irradiated remainder tissue or organ receives the highest equivalent dose of all the organs, a weighting factor of 0.025 (half of remainder) is applied to that tissue or organ and 0.025 (half of remainder) to the mass-weighted equivalent dose in the rest of the remainder tissues and organs to give the remainder equivalent dose.

[2] For the case of uniform external irradiation of the whole body, a tissue weighting factor (w_T) equal to 1 may be used in determination of the effective dose.

A. **At the WVDP:** Determinations of the effective dose shall be made using the radiation and tissue weighting factor values provided in 10 CFR 835.2. [**10 CFR 835.203(b)**].

Appendix 2D. Non-Uniform Exposure of the Skin

Non-uniform exposures of the skin from X-rays, beta radiation, and radioactive materials on the skin, including hot particles, shall be assessed and recorded as specified in the table below [see 835.205(b)].

AREA OF SKIN IRRADIATED	METHOD OF AVERAGING, ADDING TO OTHER DOSES RECEIVED, AND RECORDING NON-UNIFORM SKIN DOSE
> 100 cm^2 [see 835.205(b)(1)]	Averaged over the 100 cm^2 of skin receiving the maximum dose Added to any uniform equivalent dose also received by the skin Recorded as the equivalent dose (H) to any extremity or skin for the year
≥ 10 cm^2 and < 100 cm^2 [see 835.205(b)(2)]	Averaged over the 1 cm^2 of skin receiving the maximum absorbed dose (D), reduced by the fraction (f) which is the irradiated area in cm^2 divided by 100 cm^2 (i.e. H=fD) Added to any uniform equivalent dose also received by the skin Recorded as the annual extremity or skin equivalent dose [1]
< 10 cm^2 [see 835.205(b)(3)]	Averaged over the 1 cm^2 of skin receiving the maximum dose Not added to any other equivalent dose, extremity or skin equivalent dose recorded for the annual equivalent dose Recorded in a individual's radiation dose record as a special entry[1]

[1] Recording of the non -uniform equivalent dose to the skin is not required if the dose is less than 2 % of the limit specified for the skin at 835.202(a)(4).

At the WVDP: All skin contaminations shall be documented by the Radiation Safety organization for entry into individual dosimetry records. Radiological control procedures should be established to specify skin contamination doses above which computer programs or hand calculations for calculating the equivalent skin dose should be used. Computer programs are the preferred methodology and should be used to calculate skin doses from distributed or hot particle contamination. Detectable contamination on personnel shall be removed by approved decontamination methods established in radiological control procedures.

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CHAPTER 3 CONDUCT OF RADIOLOGICAL WORK

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PART 6. Special Applications

PART 7 [Reserved]

PART 8. Design and Control

APPENDICES

TABLES

PART 1 Planning Radiological Work

311 General

1. DOE regulations for occupational radiation protection require written authorizations to control access to and work in radiological areas [see 835.501(d)]. The level of detail included in such authorizations is dependent upon facility hazards and the nature of the work force. Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning, should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. In general, efforts to reduce individual dose should not be allowed to cause a concurrent increase in collective dose.

2. The primary methods used to maintain exposures ALARA shall be facility and equipment physical design features [see 835.1001(a)]. Performance of certain activities, such as maintenance and modifications, may render permanently installed physical design features inadequate. In such instances, a special subset of design features, often referred to as engineering controls (e.g., temporary shielding, containment devices, and filtered ventilation systems) should be used, as appropriate, to control individual exposures. Design criteria are discussed in Part 8 of this Chapter.

3. When physical design features, including engineering controls, are impractical or inadequate, they shall be augmented by administrative controls [see 835.1001(a) & (b)]. To accomplish this, the design and planning processes should incorporate radiological control considerations in the early planning stages. The checklist in Appendix 3A is helpful in reducing occupational radiation exposure.

4. To ensure adequate protection of the work force, planning for radiological work should also include consideration of all other workplace hazards (e.g., industrial hygiene and safety, fire safety, electrical safety), consistent with the principles of Integrated Safety Management as discussed in Article 118.

312 Planning for Maintenance, Operations, and Modifications

1. Work plans and procedures should be reviewed to identify and incorporate radiological control requirements, such as engineering controls and dose and contamination reduction considerations. Performance of this review should be the responsibility of line management, with support and concurrence from the radiological control organization. Where multiple hazards are present, this review should be performed by a multi-disciplinary team preparing the work control procedure**.** An integrated set of controls for all hazards (e.g., radiological, chemical, and physical) should be developed from this review.

    A. Work plans and procedures should be reviewed to identify and incorporate radiological control requirements, such as engineering controls and dose and contamination reduction considerations. Performance of this review should be the responsibility of line management, with support and concurrence from the radiological control organization. Where multiple hazards are present, this review should be performed by a multi-disciplinary team preparing the work control procedure. An integrated set of controls for all hazards (e.g., radiological, chemical, and physical) should be developed from this review.

    B. The radiological hazard assessment and control process should be integrated with the processes used to assess and control other workplace hazards. DOE Order O 440.1B, Worker Protection Program for DOE (including the National Nuclear Security Administration) Federal Employees, and its associated Guide 440.1-1A provide requirements and guidance for performing hazards assessments and implementing associated controls. This Order applies only to Federal Employees.

C. For contractors, Rule 10 CFR 851, Worker Safety and Health Program, and its associated guide, DOE G 440.1-8, Implementation Guide for use with 10 CFR PART 851, Worker Safety and Health Program, provide requirements and guidance for performing hazards assessments and implementing associated controls.

2. For routine tasks, such as surveillance, tours, and minor maintenance, performance of the above review and documentation of identified radiological protection requirements may be conducted as part of the radiological work permit process (see Article 321) or other work authorization development process that may be required by 835.501(d).

A. **At the WVDP:** The above review may be conducted as part of the controlling work document review and RWP process [*Article 113*].

3. The site-specific radiological control manual should establish trigger levels requiring formal radiological review of non-routine or complex work activities. The trigger levels should be based on radiological conditions in existence or expected prior to implementation of the job-specific engineering and administrative controls. Following are example trigger levels; each site should select trigger levels that are appropriate to their operations.

A. Estimated individual or collective dose greater than pre-established values (e.g., any individual likely to receive a dose exceeding 50% of the local administrative control level or collective dose likely to exceed 1 person-rem)

1. **At the WVDP:** The preestablished value shall be 100 person-mrem of collective dose.

B. Predicted airborne radioactivity concentrations in excess of pre-established values (e.g., greater than 10 times the applicable DAC value(s) provided in 10 CFR 835)

1. **At the WVDP:** The preestablished value shall be one Derived Air Concentration (DAC) to a worker taking into account assigned respiratory protection factors.

C. Removable contamination on accessible surfaces greater than pre-established values (e.g., greater than 100 times the values in Table 2-2)

1. **At the WVDP:** The preestablished value shall be 100 times the values in Table 2-2 for general area workplace conditions (i.e., the worker's whole body is located in a general area with high contamination levels).

D. Entry into areas where dose rates exceed 1 rem/hour

E. Potential releases of radioactive material to the environment.

1. **At the WVDP:** The predicted values shall be for radioactive liquid or airborne releases $\geq$ 1 Derived Concentration Guideline (DCG) for an individual radionuclide or $\geq$ 1 sum of fractions of the DCG for a mixture of radionuclides, per DOE O 5400.5.

4. For non-routine or complex tasks at a minimum, the radiological review should consider the following:

A. Inclusion of radiological control hold points in the technical work documents.

B. Elimination or reduction of radioactivity through line flushing and decontamination.

C. Use of work processes and special tooling to reduce time in the work area.

D. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity.

E. Specification of special radiological training or monitoring requirements.

F. Use of mock-ups for high exposure or complex tasks.

G. Engineering, design, and use of temporary shielding to reduce radiation levels.

H. Walkdown or dry-run of the activity using applicable procedures.

I. Staging and preparation of necessary materials and special tools.

J. Maximization of prefabrication and shop work.

K. Review of abnormal and emergency procedures and plans.

L. Identification of points where signatures and second party or independent verifications are required.

M. Establishment of success or completion criteria, with contingency plans to anticipate difficulties.

N. Development of a pre-job estimate of collective dose to be incurred for the job.

O. Provisions for waste minimization and disposal.

P. Identification of potential environmental releases.

5. The extent of the radiological review should be commensurate with the expected and potential hazards and required controls.

6. Radiological control requirements identified as part of the above radiological review should be documented in the job plans, procedures, or work packages.

   A. Line management and the radiological control organization should provide enhanced oversight during the initiation and conduct of the work.

7. The ALARA Committee should review and approve plans for radiological work anticipated to exceed site-specific individual or collective dose criteria.

   A. **At the WVDP:** The criteria should be 1.0 person-rem collective dose.

8. Optimization techniques, such as cost-benefit analyses, represent a fundamental part of radiological design analysis and work review. For review of minor activities with low associated doses, a cost-benefit evaluation is an intrinsic part of the engineering review process and a detailed evaluation is not necessary. For review and planning of major tasks involving higher collective dose expenditures, a detailed and documented evaluation should be performed.

   A. **At the WVDP:** Low associated doses should be defined as < 1.0 person-rem and high collective dose expenditures ≥ 1.0 person-rem. Detailed and documented evaluations should be performed only when applicable for a work activity (e.g., installation or design of permanent shielding for a facility, etc.).

9. **At the WVDP:** Detailed procedures incorporating radiological and other safety considerations are required for complex operations in radiological areas. The written procedure becomes a step-by-step instruction to the personnel performing the operation.

   A. Prior to being issued for use, the procedure should be reviewed and approved by designated Radiation Safety organization personnel.

   B. Operating organizations should consult with Radiation Safety personnel in the preparation of procedures, work plans, and designs which present actual or potential radiological hazards or which may impact the environment. It is the responsibility of the procedure writer to include the essential radiological control criteria within the procedure.

10. **At the WVDP:** The ALARA program incorporates measures for reducing occupational radiation exposures through physical, administrative, and procedural control mechanisms. The Radiation Safety organization scrutiny of all proposed new facilities, site modifications, or activities shall be performed when changes are imminent or proposed.

11. **At the WVDP:** Radiation exposure data should be analyzed on an individual basis and by exposure group.

12. **At the WVDP:** The ALARA review conducted by the Radiation Safety organization per Article 312.5 should be performed as part of the work document review process.

313 Infrequent or First-Time Activities

In addition to the planning provisions of Article 312, special management attention should be directed to radiological activities that are infrequently conducted (i.e., activities for which there is insufficient facility or worker planning and execution experience to provide assurance of adequate radiological controls) or represent first-time operations. Planning for such activities should include:

1. Formal radiological review in accordance with Article 312.4

2. Senior management review directed toward anticipation of concerns and emphasis and specification of protective measures

3. Review and approval by the ALARA Committee

4. Enhanced line and radiological control organization management oversight during the initiation and conduct of the work.

5. The extent of the formal radiological review should be commensurate with the expected and potential hazards and required controls.

At the WVDP: For purposes of this Article a graded approach has been adopted where:

- Infrequent or first-time radiological work activities and operations that do not exceed the ALARA trigger levels in Article 312.3 will be reviewed and approved by Radiological Engineering.

- Infrequent or first-time radiological work activities and operations that exceed the ALARA trigger levels in Article 312.3 will require a formal, documented ALARA review per Article 312.5 in addition to the above requirement.

- Infrequent or first-time radiological work activities and operations that exceed a collective dose of 1.0 person-rem will be reviewed and approved by the ALARA Committee per Article 312.7 in addition to the above requirement.

- Infrequent or first-time radiological work activities and operations that involve the direct handling or transfer of a potentially Releasable Quantity (RQ) of radioactive material (or sum of ratios) meeting or exceeding the value(s) listed in Title 40, Code of Federal Regulations, Part 302.4, Appendix B to Table 302.4 (i.e., the quantity that defines a DOE Radiological Facility) will be brought to the attention of the ALARA Committee and Radiation and Safety Committee by the Cognizant Department Manager, with the Radiation and Safety Committee performing the senior management review described in Article 313.2 and the ALARA Committee review and approval per Article 313.3, in addition to the above requirement.

314 Temporary Shielding

1. The installation, use, and removal of temporary shielding needed to prevent exposure in high radiation areas should be controlled by postings or procedure.

2. The effects of the additional weight of temporary shielding on systems and components should be evaluated and established to be within the design basis prior to installation.

   A. **At the WVDP:** The effects of the additional weight of temporary shielding on systems, such as floor loading, structural supports, etc., and components, such as pipe loading, structural supports, vessels, should be performed by the cognizant engineering group.

3. Installed temporary shielding should be periodically inspected and surveyed to verify effectiveness and integrity. Installed temporary shielding should be periodically evaluated to assess the need for its removal or replacement with permanent shielding.

   A. **At the WVDP:** The shielding should be surveyed by Radiation Safety organization personnel to verify effectiveness and integrity. If any problems or deficiencies are noted, the radiological control organization should notify the cognizant work or engineering group.

   B. **At the WVDP:** Depending on the type of temporary shielding, inspections may be made by the cognizant work or engineering group, or the Radiation Safety organization, to verify the physical condition of the temporary shielding.

   C. **At the WVDP:** The periodic evaluation should be performed by the facility management / supervision.

4. Radiation surveys should be performed during the alteration or removal of installed temporary shielding as appropriate.

5. Removable shielding needed to prevent access to a high radiation area should be visibly marked or labeled with the following or equivalent wording: "Radiation Shielding - Do Not Remove without Permission from Radiological Control."

6. Site procedures may identify specific shielding applications, such as the shielding of low activity sources or samples that fall outside the recommendations of this Article.

   A. **At the WVDP:** Shielding installed as a temporary ALARA measure, such as on a waste box or container being relocated within a facility, and that is being directly controlled by Radiation Safety organization personnel, falls outside the recommendations of this Article.

315 Technical Work Documents

1. Technical work documents, such as procedures, work packages, or job or research plans, should be used to control hands-on work with radioactive materials. Requirements for incidental or routine work activities that involve a low potential of worker exposure or workplace contamination, such as the collection of trash or used protective clothing, should be established in generally applicable procedures.

2. Technical work documents used to control radiological work activities should be reviewed by and acceptable to the radiological control organization.

3. Radiological control hold points should be incorporated into technical work documents for steps or conditions that require action by the radiological control organization to assess existing radiological conditions or prevent significant adverse radiological consequences during subsequent steps. Sites should define "significant adverse radiological conditions" that require the use of radiological control hold points in the site-specific radiological control manual. The following activities and potential conditions should be considered for inclusion in the requirements for radiological control hold points:

   A. Radiological control organization action needed to assess changing radiological conditions and ensure implementation of required controls

   B. Potential for radiation doses in excess of the applicable site-specific administrative control level

   C. Potential for elevated airborne radioactivity levels (e.g., levels exceeding 10 times the DAC values provided in Appendices A and C of 10 CFR 835)

   D. Potential for elevated removable surface contamination levels on accessible surfaces (e.g., levels exceeding 100 times the Table 2-2 values)

   E. Potential for unplanned or uncontrolled release of radioactive material to the environment.

   At the WVDP: Significant adverse radiological conditions are defined as conditions that may exceed the protection factor or PPE levels or that may exceed the administrative control levels for individuals.

4. The radiological control hold point should include the criteria that must be met or action that must be taken to satisfy the hold point prior to continuing with subsequent steps in the planned activity. Radiological control limiting conditions typically provide conditions which, if encountered, require some action, such as stopping work. Examples of radiological control limiting conditions would be encountering unanticipated levels for; dose, dose rate, removable surface contamination, airborne radioactivity concentrations, etc. (See appendix 3E, *Radiological Control Limiting Conditions.)*

316 Control of Internal Exposure

1. The primary methods used to maintain individual internal doses ALARA shall be physical design features, such as confinement, ventilation, and remote handling [see 835.1001(a)]. The design objective shall be, under normal conditions, to avoid releases of radioactive material to the workplace atmosphere. The objective, under all conditions, shall be to control inhalation of radioactive material to levels that are ALARA [see 835.1002(c)].

2. Administrative controls, including access restrictions and the use of specific work practices designed to control airborne radioactivity, shall be used as the secondary method to maintain internal doses ALARA [see 835.1001(b)].

3. When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection should be used to limit internal exposures. Use of respiratory protection should be considered under the following conditions:

   A. Entry into airborne radioactivity areas

   B. During breach of contaminated systems or components

   C. During work in areas or on equipment with removable contamination levels greater than 100 times the values in Table 2-2

   D. During work on contaminated or activated surfaces with the potential to generate airborne radioactivity.

4. The selection of respiratory protection equipment should include consideration of worker safety, comfort, and efficiency. The use of positive pressure respiratory protection devices is recommended wherever practicable to alleviate fatigue and increase comfort. See Chapter 5, Part 3, for additional guidance on respiratory protection.

5. In specific situations, the use of respiratory protection may be inadvisable due to physical limitations or the potential for significantly increased external exposure. In such situations, and if the anticipated internal dose is likely to exceed 0.1 rem, a formal radiological review should be conducted to ensure measures are implemented to assess available options, monitor and reduce worker exposure, and provide for follow-up monitoring, as required. The rationale for not requiring respiratory protection**,**, including a description of measures taken to mitigate the airborne radioactivity, should be documented as part of the review process.

6. The following controls are applicable to activities authorized in accordance with the above:

   A. Stay time controls to limit intake should be established for the entry

   B. Evaluation of workplace airborne radioactivity levels should be provided through the use of continuous air monitors or air samplers with expedited assessment and analysis of results.

7. When notified that an individual with an open wound wishes to enter an area where contact with radioactive contamination is possible, a representative of the radiological control organization or medical services should examine the wound and require appropriate measures to prevent the entry of radioactive contamination. These measures may be range from requiring an appropriate bandage or other covering up to prohibiting access to affected areas until the wound has healed. If other (non-radiological) hazards are present in the area to be entered, the individual should be directed to contact the applicable safety personnel.

PART 2 Work Preparation

321 Radiological Work Permits

The RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities.

1. The RWP should be integrated with other work authorizations that address safety and health issues, such as those for industrial safety and hygiene, welding, or confined space entry. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in this Article and Articles 322 and 323.The RWP should include the following information, unless the information is contained in other related work-control documents:

    A. Description of work
    B. Work area radiological conditions
    C. Dosimetry requirements, including any bioassay requirements
    D. Pre-job briefing requirements, as applicable
    E. Training requirements for entry
    F. Protective clothing and respiratory protection requirements
    G. Radiological Control coverage requirements and stay time controls, as applicable
    H. Limiting radiological conditions that may void the RWP
    I. Special dose or contamination reduction considerations
    J. Special personnel frisking considerations
    K. Technical work document number, as applicable
    L. Unique identifying number
    M. Date of issue and expiration
    N. Authorizing signatures.

2. If necessary to ensure appropriate accounting, the RWP number should be used in conjunction with the radiation dose accounting system to relate individual and/or collective dose to specific activities.

3. **At the WVDP:** The pre-job briefing requirement should be included in the technical work document [*Article 113*].

322 Use of Radiological Work Permits

Many facilities find it effective to use two different types of RWPs. General RWPS are used for entry and repetitive work in areas with known and stable low-hazard radiological conditions. Job-specific RWPs are used for more complex work and for entry into higher-hazard areas.

1. RWPs should be used to control the following activities:

    A. Entry into radiological areas

        At the WVDP: An Article 113 Determination was approved for this Article statement in which [*Article 113*]:

        - RWPs should be used to control work activities performed in radiological areas.
        - Except Radiation Areas, RWPs should be used to control entry into radiological areas.

- The WVDP Radiological Controls Manual provides the written authorization, per 10 CFR 835.501(d), for entry into Radiation Areas for non-work related activities (e.g., observation, walk-throughs, tours, inspections, or surveillances). See Article 334.

- An alternate formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities per Article 322.8.

B. Handling of materials with removable contamination that exceed the values of Table 2-2

C. Work in localized benchtop areas, laboratory fume hoods, sample sinks, and containment devices that has the potential to generate contamination in areas that are otherwise free of contamination

D. Work that disturbs the soil in soil contamination areas

E. Work that involves digging in underground radioactive material areas

F. **At the WVDP:** When required by the work document

G. **At the WVDP:** Entry into any Contamination Area by non-radiological worker trained individuals

H. **At the WVDP:** Any work at an elevation greater than seven (7) feet above the floor within the Main Plant Process Building, unless determined not to be required by the Radiation Safety Manager or Radiation Safety Supervisors.

I. **At the WVDP:** Any work that requires contact with or opening of process piping or equipment (including interceptor piping, primary process piping, transfer lines, etc.) and associated utility systems, chemical addition systems, demineralized water systems, vacuum lines, potentially radiologically contaminated drain lines, or any potentially radiologically contaminated system

J. **At the WVDP:** Breaching ventilation systems servicing radiological areas

K. **At the WVDP:** All site excavations

L. **At the WVDP:** All radiography operations

M. **At the WVDP:** Any work performed in any other area that Radiation Safety organization personnel have determined to require an RWP

2. Job-specific RWPs should be used to control non-routine operations or work in areas with changing radiological conditions. The job-specific RWP should remain in effect only for the duration of the job.

3. General RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with well-characterized and stable radiological conditions. General RWPs should be periodically reviewed and updated, consistent with the site ISM process.

A. **At the WVDP:** Radiological control requirements contained in approved written procedures shall be approved during the procedure review cycle as set forth in WVDP-257 or the governing administrative procedure, or whenever a revision is required to the procedure [*Article 113*].

B. **At the WVDP:** When determining if a general RWP or approved written procedure may govern a radiological work activity per Article 322.8, the degree of radiological hazards involved shall be taken into consideration. If the radiological hazards are high, then an RWP shall be used instead of an approved written procedure [*Article 113*].

4. RWPs should be updated if radiological conditions change to the extent that protective requirements need modification.

A. **At the WVDP:** Radiological surveys shall be routinely reviewed to evaluate adequacy of radiological control requirements incorporated into approved written procedures used in lieu of an RWP per Article 322.8 [*Article 113*].

B. **At the WVDP:** RWPs shall be issued to supercede the radiological control requirements in approved procedures of radiological conditions change to the extent that protective requirements need modification [*Article 113*].

5. RWPs should be posted at the access point to the applicable radiological work area or otherwise made available at the work location.

A. **At the WVDP:** In cases where there is no convenient location for posting, the RWP shall be in possession of the workers and available at the work location. This should ensure that personnel are aware of both the radiological conditions in a work area and the requirements for entry into the area [*Article 113*].

B. **At the WVDP:** Approved written procedures used in lieu of an RWP per Article 322.8 should be available at the access point to the applicable radiological work area [*Article 113*].

6. Workers should acknowledge by signature or through electronic means where automated access systems are in place, that they have read, understand, and will comply with the RWP prior to initial entry to the area and after revisions to the RWP that affect the radiological controls.

A. **At the WVDP:** Workers shall acknowledge by signature that they have read, understand, and will comply with the requirements of the approved written procedure used in lieu of an RWP per Article 322.8 and after any revisions to the approved written procedure [*Article 113*].

B. **At the WVDP:** A change or revision to the radiological control requirements contained in an approved procedure used in lieu of an RWP per Article 322.9 requires supplemental training (e.g., workplace briefing, required reading, etc.) and the worker's signature documented verifying that he/she understands and will comply with the change [*Article 113*].

7. If needed for dose accounting purposes, worker pocket or electronic dosimeter readings should be recorded in a format that identifies and provides linkage to the applicable RWP.

A. **At the WVDP:** The supplemental dosimeter values are recorded in the RSO Toolkit database.

8. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in this Article and Articles 321 and 323.

   A. **At the WVDP:** Radiological surveys performed by RCTs in support of RWPs do not require a separate RWP to be issued. The Radiation Safety organization should maintain procedures for RCTs on performing radiological surveys, instrument checks, and inspections and incorporate radiological safety precautions as appropriate and when necessary into the procedures.

   B. **At the WVDP:** In cases where an area is posted for contamination, an RWP should be issued except for routine work that is controlled by a procedure which prescribes the anti-contamination clothing and safety requirements for the operation. This procedure should be approved by the Radiation Safety Manager or designee.

   C. **At the WVDP:** Alternate mechanisms are defined as approved written procedures that include, but are not limited to: Standard Operating Procedures (SOPs); Job Cards per WV-108 and WV-109; and Department Procedures per WVDP-257 [*Article 113*].

   D. **At the WVDP:** Not all Article statements contained in Article 321, 322, and 323 are applicable to approved written procedures when used in lieu of RWP's. Therefore, the exceptions are noted with the specific Article statement [*Article 113*].

9. **At the WVDP:** The Radiation Safety organization should determine the degree of monitoring and controls required for work to be performed. This may include survey requirements, special dosimetry, and protective clothing and equipment.

   A. Prior to the work being performed, the RCT should determine exposure levels and time limits for the job and assign stay times if exposure levels necessitate.

   B. Stay times, if assigned, should control individual exposure within the WVDP Administrative Control Levels.

10. **At the WVDP:** That portion of the RWP which includes location, details of the job, date, and work document identifier should be completed by the personnel requesting the RWP. The Radiation Safety organization should complete the sections pertaining to radiological controls.

    A. When possible, personnel who request the RWP, should notify the Radiation Safety organization one day prior to when the RWP is needed to ensure no work delays occur.

11. **At the WVDP:** It is the responsibility of the sponsoring (cognizant) engineer to monitor the working habits of subcontract personnel to ensure that specified work is being performed in such a manner that personnel dose is maintained ALARA.

12. **At the WVDP:** Following completion of the task specified in the RWP, personal contamination survey data, and any unusual or unanticipated radiological conditions should reference the RWP.

323 Radiological Work Permit Preparation

1. The responsibility for ensuring adequate planning and control of work activities resides with line management. The lead work group responsible for the planned activity or for the area should initiate the preparation of the RWP.

   A. **At the WVDP:** The lead work group responsible for the planned activity or for the area should initiate the preparation of the approved written procedure used in lieu of an RWP per Article 322.8 [*Article 113*].

2. The RWP should be based on current radiological surveys and anticipated radiological conditions.

   A. **At the WVDP:** Pre-work radiological surveys should include a thorough survey for removable contamination as well as general area radiation levels and any hot spots.

   B. **At the WVDP:** The approved written procedure used in lieu of an RWP per Article 322.8 shall be based on current radiological surveys and anticipated radiological conditions [*Article 113*].

3. The RWP, including any revisions or extensions, should be approved by the supervisor responsible for the work or area, followed by review and concurrence by the appropriate radiological control supervisor.

   A. **At the WVDP:** Approved written procedures used in lieu of an RWP per Article 322.8 shall be reviewed and approved by the Radiation Safety organization [*Article 113*].

   B. **At the WVDP:** Approved written procedures used in lieu of an RWP per Article 322.8 for the work area shall be approved by the Facility Manager and/or the Cognizant System Engineer, or in accordance with the governing administrative procedure, and by the Radiation Safety organization. Revisions to the approved written procedures shall be subject to the same approval process [*Article 113*].

324 Pre-Job Briefings

1. At a minimum, pre-job briefings should be held prior to the conduct of work anticipated to exceed the trigger levels identified in Article 312.3.

   A. **At the WVDP:** Radiological surveys, routine plant inspections, and routine observation activities are not applicable to this requirement.

2. At a minimum, the pre-job briefing should include:

   A. Scope of work to be performed
   B. Radiological conditions of the workplace
   C. Procedural and RWP requirements
   D. Special radiological control requirements
   E. Radiologically limiting conditions, such as contamination or radiation levels that may void the RWP
   F. Radiological control hold points
   G. Communications and coordination with other groups
   H. Provisions for housekeeping and final cleanup
   I. Emergency response provisions.

3. Pre-job briefings should be conducted by the cognizant work supervisor or other individuals most familiar with the work to be performed and the required controls.

4. Workers and supervisors directly participating in the job, cognizant radiological control personnel, and representatives from involved support organizations should attend the briefing.

5. Attendance at the pre-job briefing should be documented. This documentation should be maintained with the technical work document.

325 Use of Personal Protective Equipment and Clothing

1. Individuals shall wear protective clothing during work in contamination and high contamination areas [see 835.1102(e)] and should wear protective clothing during the following activities:

   A. Handling of contaminated materials with removable contamination in excess of Table 2-2 levels

   B. Work in airborne radioactivity areas

   C. As directed by the radiological control organization or as required by the RWP or other work authorization.

2. Protective clothing and shoes designated for radiological control should be:

   A. Distinctive

   B. Used only for its intended purposes.

   At the WVDP: Radiological Worker training is considered a radiological control purpose.

3. Workers should proceed directly to the designated area after donning personal protective equipment and clothing.

4. General guidelines for protective clothing selection and use are provided in Appendix 3C and in Table 3-1.

5. The use of labcoats as radiological protective clothing is appropriate for limited applications, such as those discussed in Appendix 3C where the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Labcoats should not be used as protective clothing for performing physical work activities in contamination, high contamination, or airborne radioactivity areas where contamination of the lower legs is likely.

6. As appropriate for the work conditions, the RCO should consider posting instructions for donning and removing protective clothing at the dress-out areas and step-off pad(s) for the affected work areas.

7. The use of personal protective equipment or clothing (including respiratory protection) beyond that authorized by the radiological control organization or other cognizant safety authorities detracts from work performance and is contrary to ALARA principles and waste minimization practices. Such use should not be authorized.

8. For radiological control purposes, company-issued clothing that is not specifically intended to protect individuals from contamination hazards should be considered the same as personal clothing.

PART 3 Entry and Exit Provisions

331 Controlled Areas

1. DOE regulations for occupational radiation protection require that individuals complete radiation safety training commensurate with the hazards and required controls:

   A. Prior to unescorted access to controlled areas [see 835.901(a)]; and

   B. Prior to receiving occupational dose during access to controlled areas (whether escorted or not) [see 835.901(a)].

2. Training provisions for unescorted entry into controlled areas and radiological areas are specified in Table 3-1. Article 622 establishes training provisions that should be met prior to permitting members of the public in controlled areas.

332 Radiological Buffer Areas

1. Minimum requirements for unescorted entry into radiological buffer areas should include the following:

   A. Training in accordance with Table 3-1

   B. Primary dosimeter, as appropriate.

2. Contamination monitoring provisions for individuals who exit a radiological buffer area containing contamination areas, high contamination areas, or airborne radioactivity areas are specified in Article 338.

3. **At the WVDP:** Radiological Buffer areas should be established prior to entry into a radiological area where deemed necessary by the Radiation Safety organization.

4. **At the WVDP:** Tour groups may enter a Radiological Buffer Area with a qualified radiological worker escort who is wearing a personnel dosimeter in accordance with Article 511.

333 Radioactive Material, Soil Contamination, and Underground Radioactive Material Areas

Minimum requirements for unescorted entry into radioactive material areas, soil contamination areas, and underground radioactive material areas should include training in accordance with Table 3-1. If individual doses are likely to exceed the applicable monitoring thresholds, individual monitoring shall be conducted in accordance with Article 511 and Article 521 [see 835.402(a) and (c)].

334 Radiation, High Radiation, and Very High Radiation Areas

1. Minimum requirements for unescorted entry into radiation areas shall include radiation safety training [see 835.901(b)] and should include the following:

   A. Training in accordance with Table 3-1

   B. Worker's signature on the RWP, as applicable

   C. Primary dosimeter.

2. Physical controls to prevent inadvertent or unauthorized access to high and very high radiation areas are established in Appendix 3B.

3. Minimum requirements for unescorted entry into high radiation areas shall include radiation safety training [see 835.901(b)], a primary dosimeter [see 835.402(a)(5)], a radiation survey, and supplemental dosimeter [see 835.502(a)] and should include the following:

   A. Training in accordance with Table 3-1

   B. Worker's signature on the RWP.

4. Minimum requirements for unescorted entry into high radiation areas where dose rates exist such that an individual could exceed a whole body dose of 1 rem in one hour shall include radiation safety training [see 835.901(b)], a personnel (primary) dosimeter [see 835.402(a)(5)], a radiation survey, and supplemental dosimeter [see 835.502(a)] and should include the following:

   A. Training in accordance with Table 3-1

   B. Worker's signature on the RWP

   C. A determination of the individual’s current dose, based on primary and supplemental dosimeter readings

   D. Pre-job briefing, as applicable

   E. Review and determination by the radiological control organization regarding the required level of radiological control technician coverage.

5. Individuals shall be prevented from unauthorized or inadvertent entry to very high radiation areas [see 835.502(c)]. In addition to the controls required in Articles 334.2 and 334.3, a survey should be performed prior to the first entry to the area after the source has been secured or shielded to verify the termination of the very high radiation field.

6. Operations personnel should immediately notify the radiological control organization of operational or system changes that could result in significant changes in radiological hazards. Such notifications facilitate radiological control organization actions to erect postings and implement required entry controls.

7. The number, issue, and use of keys should be strictly controlled where locked entryways are used to control access to high and very high radiation areas.

8. The radiological control organization should maintain a list of high and very high radiation areas.

9. Written procedures should be implemented to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Determination of the effectiveness of these control devices should also consider individual training and response. Weekly inspections of the physical access controls to high and very high radiation areas should be performed to verify controls are adequate to prevent unauthorized entry.

10. **At the WVDP:** Personnel entry control shall be maintained for each radiological area [**10 CFR 835.501(a)**].

11. **At the WVDP:** The degree of control shall be commensurate with existing and potential radiological hazards within the area [**10 CFR 835.501(b)**].

12. **At the WVDP:** One or more of the following methods shall be used to ensure control [**10 CFR 835.501(c)**]:

    A. Signs and barricades;

    B. Control devices on entrances;

    C. Conspicuous visual and/or audible alarms;

    D. Locked entrance ways; or

    E. Administrative controls.

13. **At the WVDP:** If a non-radiological trained worker requires entry into a Radiation Area and will not require repeated or frequent entries, the requirements are:

    A. Assignment of a temporary TLD badge;

    B. Escort by a qualified radiological worker at all times while in the Radiation Area;

    C. No access to any area where there is a significant risk of internal deposition of radioactive material; and

    D. Application of the following WVDP Administrative Control Levels and exposure controls:

        1. Non-radiological trained workers should not exceed a total effective dose of 100 mrem per year.

        2. A visitor to the WVDP shall not exceed an total effective dose of 100 mrem per year.

        3. No non-radiological worker shall be issued visitor dosimetry, if during the present visit, it is anticipated that the person may exceed the 100 mrem total effective dose or any other administrative control level.

14. **At the WVDP:** If the non-radiological trained worker is to make repeated entries into the Radiation Area, the individual should become radiological worker qualified and meet the appropriate requirements addressed in Article 632, as appropriate. In addition, the non-radiological worker's exposure history shall be reviewed by the dosimetry office prior to the person re-entering a Radiation Area.

15. **At the WVDP:** Entry into Radiation Areas for non-work related activities (e.g., observations, walk-throughs, tours, inspections, or surveillances) shall comply with the requirements of Article 334.1.

The WVDP RCM provides the written authorization, per 10 CFR 835.501(d), for entry into Radiation Areas for non-work related activities.

335 Contamination, High Contamination, and Airborne Radioactivity Areas

1. Minimum requirements for unescorted entry into contamination areas shall include radiation safety training [see 835.901(b)] and protective clothing [see 835.1102(e)] and should include the following:

   A. Training in accordance with Table 3-1

   B. Worker's signature on the RWP, as applicable

   C. Personnel dosimetry, as appropriate.

2. Minimum requirements for unescorted entry into high contamination or airborne radioactivity areas shall include radiation safety training [see 835.901(b)] and protective clothing [see 835.1102(e)] and should include the following:

   A. Training in accordance with Table 3-1

   B. Worker's signature on the RWP

   C. Respiratory protection when specified by the RWP or other written authorization

   D. Pre-job briefing for high contamination or airborne radioactivity areas, as applicable

   E. Personnel dosimetry, as appropriate.

3. Individuals exiting contamination, high contamination, or airborne radioactivity areas should remove protective clothing (See Appendix 3C for recommended procedure). When entering an uncontaminated area, these individuals shall be monitored, as appropriate, for the presence of contamination on their skin and clothing [see 835.1102(d)]. These individuals should perform whole body frisking to detect personnel contamination in accordance with Article 338.

4. Exit points from contamination, high contamination, or airborne radioactivity areas should include the following:

   A. Step-off pad located outside the exit point, contiguous with the area boundary

   B. Step-off pads maintained free of radioactive contamination

   C. Designated containers inside the area boundary for the collection of protective clothing and equipment

   D. Contamination monitoring equipment located as close to the step-off pad as background radiation levels permit.

5. Multiple step-off pads should be used at the exits from high contamination areas. Use of multiple step-off pads is described in Appendix 3C.

6. Protective clothing and monitoring provisions specific to benchtop work, laboratory fume hoods, sample stations, and gloveboxes are identified in Article 347.

7. Article 421 provides requirements and guidance for removing materials and equipment from these areas.

8. **At the WVDP:** The degree of control shall be commensurate with existing and potential radiological hazards within the area [**10 CFR 835.501(b)**].

9. **At the WVDP:** Access by Radiological Worker I and non-radiological trained workers to Contamination Areas for observation only (i.e., no work), requires the following:

   A. Radiation Work Permit (RWP);

   B. Continuous escort by a qualified RCT;

   C. Proper protective equipment per RWP requirements;

   D. Visitor dosimeter and completion of form WV-1128 for non-radiological trained workers;

   E. Written approval by Radiation Safety Manager (e.g., signature on RWP);

   F. Documented personnel contamination survey upon exiting the radiological area (i.e., RWP personnel release).

   Access by Radiological Worker I and non-radiological trained workers to Contamination Areas for "hands on" work requires appropriate bioassay (i.e., *In Vivo* measurements and/or *In Vitro* sampling) in addition to the above requirements.

336 Member of the Public Entry Provisions

1. Site procedures should identify area entry requirements and access restrictions for members of the public.

2. Members of the public with a demonstrated need to enter the following areas may be allowed access if such access is controlled with a combination of orientation and the use of escorts trained for the specific area:

   A. Radiological buffer areas

   B. Radiation areas

   C. Contamination areas

   D. Radioactive material areas

   E. Soil contamination areas

   F. Underground radioactive material areas

3. Members of the public should be prohibited from entering very high radiation, high radiation, high contamination, and airborne radioactivity areas.

4. Orientation provisions for members of the public are identified in Article 622.

337 Controlling the Spread of Contamination

Controls shall be implemented as necessary to prevent the spread of removable contamination outside of radiological areas under normal operating conditions [see 835.1102(a)]. The extent of these controls is dependent upon the type and level of contamination present and the activities in and around the area. The following measures should be used to prevent the spread of contamination across the boundaries of contamination, high contamination, and airborne radioactivity areas:

1. Use solid barriers to enclose areas wherever practicable

2. Mark and secure items such as hoses and cords that cross the boundary to prevent safety hazards and the spread of contamination. Markings may include radiological hazard warning labels, ribbon, or tape.

3. Control and direct airflow from areas of lesser to greater removable contamination or airborne radioactivity

4. Use engineering controls and containment devices such as glovebags, gloveboxes, and tents.

5. **At the WVDP:** Use filtered air handling systems or other devices in contamination containments that keep the containment area at a slightly negative pressure with respect to areas exterior to the containment. These containments when not in use are exempt from the routine survey program.

6. **At the WVDP:** Use fume hoods, glove boxes, and tents as contamination containments. Specific guidelines for the construction of contamination containments appear in Article 342. Radiological containment cells (where equipment has been intentionally designed or designated to come in contact with high levels of loose contamination) are also exempted from the routine survey program.

338 Monitoring for Personnel Contamination

1. Individuals shall be monitored as appropriate for the presence of surface contamination when exiting contamination, high contamination, and airborne radioactivity areas [see 835.1102(d)]. Individuals should perform a whole body frisk immediately upon entry into an uncontaminated area after exiting contamination, high contamination, or airborne radioactivity areas. Individuals should also perform a whole body frisk as directed by the RWP or the radiological control organization.

   A. **At the WVDP:** For contamination areas that are adjacent to a radiological buffer area, where the individual reaches into the contamination area from the buffer area to touch contaminated surfaces, individuals may perform a hand frisk on removing their hands from the area, as long as a whole body frisk (or equivalent) is performed when exiting the radiological buffer area. *[Article 113].*

2. In addition to the above, individuals exiting a radiological buffer area containing contamination, high contamination, or airborne radioactivity areas should, at a minimum, perform a hand and foot frisk. This frisk is optional if the radiological buffer area exit is immediately adjacent to the location where the exiting individual has already performed a whole body frisk.

   A. **At the WVDP:** Personnel exiting a Radiological Buffer Area containing contaminated areas shall perform a whole body frisk, at a minimum.

3. Where frisking cannot be performed at the exit from contamination, high contamination, or airborne radioactivity areas due to high background radiation levels, individuals should:

   A. Remove all protective equipment and clothing at the exit

   B. Proceed directly to the nearest designated monitoring station

   C. Conduct a whole body frisk.

4. Personnel frisking should be performed after removal of protective clothing and prior to washing or showering.

5. Guidelines for personnel frisking are provided in Appendix 3D.

6. Personal items, such as notebooks, papers, and flashlights, may be frisked by the individual carrying them, provided the individual has been trained to perform this function.

   A. **At the WVDP:** Personal items do not include tools or equipment normally used for repair or adjustment of other equipment that resides in radiological areas.

7. Instructions for personnel frisking should be posted adjacent to personnel frisking instruments or monitors.

8. The personnel frisking provisions in this Article are not applicable at those facilities that contain only radionuclides, such as tritium, that cannot be detected by currently available hand-held or automated frisking instrumentation.

9. **At the WVDP:** Surveying for personal contamination is the responsibility of and shall be performed only by individuals who are qualified as a radiological worker (Article 632). Individuals who are not radiological worker qualified exiting Radiological Buffer Areas should use automatic monitoring units under the observation of their qualified radiological worker escort. RCTs shall frisk all non-radiological workers exiting areas that do not have automatic monitoring devices. The instructions for using the equipment, the acceptable limits of contamination if not an alarming frisker, and the action to be taken if any individual alarms the frisker or exceeds the limits should be posted at each survey station.

10. **At the WVDP:** If any personal contamination is detected as indicated by a frisker or automatic monitoring unit alarm, Radiation Safety organization personnel shall be notified immediately. Contaminated individuals shall limit their movements as much as possible. Each instance of skin contamination should be investigated and documented as per Articles 127 and 722 and a copy of the report placed in the individual's dosimetry file.

11. **At the WVDP:** Only qualified radiological workers may perform self-frisking. Self-frisking means determining contamination levels on and by the worker, without the assistance of a qualified RCT.

Table 3-1. Radiological Control Training Guidelines

ACTIVITIES	MINIMUM TRAINING	ARTICLE #(s)
Member of the public entry[1]	Orientation	622
Unescorted entry into controlled areas and radioactive material areas/underground radioactive material areas where an individual is not likely to receive 0.1 rem in a year	GERT	612, 613, 621
Unescorted entry into radiological buffer areas	RWI	612, 613, 631, 632
Unescorted entry into radioactive material areas/underground radioactive material areas (>0.1 rem in a year)		
Unescorted entry into soil contamination areas for work that does not disturb the soil		
Unescorted entry into radiation areas		
Unescorted entry into contaminated areas[2]	RWII	612, 613, 631, 633
Unescorted entry into high radiation areas[3]		
Unescorted entry into soil contamination areas to perform work that disturbs the soil		
Use of containment devices with high contamination levels[4]		

Notes:

1. The radiological control manager may authorize exceptions to the escort requirements in accordance with Article 622.

2. Includes Contamination, High Contamination, and Airborne Radioactivity Areas.

3. This requirement may be satisfied by completing both RWI training and High Radiation Area Training in lieu of RWII training.

4. Includes glove boxes and other containment devices with surface contamination levels exceeding 100 times Table 2-2 values.

PART 4 Radiological Work Controls

341 General

1. Radiological work activities shall be conducted as specified by the controlling written authorization [see 835.501(d)].

2. Prerequisite conditions, such as tag-outs and system isolation, should be verified in accordance with the technical work documents before work is initiated.

342 Work Conduct and Practices

The following work practices have been shown to be effective; line management and the RCO should consider implementing these practices, as appropriate, into ongoing operations and maintenance work.

1. Monitor contamination levels caused by ongoing work and maintain them ALARA. Curtail work and perform decontamination at preestablished levels, taking into account worker exposure.

2. Inspect tools and equipment to verify operability before being brought into contamination, high contamination, or airborne radioactivity areas.

3. Minimize the use of radiologically clean tools or equipment in contamination, high contamination, or airborne radioactivity areas by implementation of a contaminated tool crib in accordance with Article 442.5. When such use is necessary, consider wrapping or sleeving tools or equipment in complex or inaccessible areas to minimize contamination.

4. Install Engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, in accordance with the technical work documents and inspect them prior to use.

5. Verify the identity of components and systems prior to work.

6. Schedule work activities and shift changes to prevent idle time in radiological areas.

7. Where practicable, remove parts and components to areas with lower radiological hazards to perform work.

8. Upon identification of radiological concerns, such as inappropriate work controls or procedural deficiencies, workers should immediately report the concern to line supervision or the radiological control organization. If appropriate to control individual exposure to radiological hazards, the affected individuals should exit the radiological area until these issues are resolved and appropriate controls have been instituted.

9. Include requirements for area cleanup in technical work documents.

10. To minimize intakes of radioactive material, do not permit smoking, eating, or chewing in contamination, high contamination, or airborne radioactivity areas. When the potential for personnel heat stress exists, drinking may be permitted within a contamination area under the following conditions and controls:

    A. The potential for heat stress cannot be reduced by the use of administrative or engineering controls

    B. All drinking is from approved containers or sources

    C. The applicable requirements and controls are described in approved procedures.

At the WVDP: Smoking, eating, or chewing should not be permitted in Radiological Buffer Areas unless approved by the Radiation Safety organization.

11. Check **c**ommunication systems required by the radiological work permit or technical work document for operability before being brought into the work area and periodically during work.

12. Workers should keep radiological control personnel informed of the status of work activities that affect radiological conditions.

13. **At the WVDP:** On infrequent occasions, it may be necessary to perform special work on radioactively contaminated materials in areas not normally radiologically controlled. The Radiation Safety Manager shall approve in writing any such proposed operations prior to the start of the operation. All radiological work in such areas requires a RWP as well as a work instruction package or other approved procedure. Appropriate controls should be required by the Radiation Safety organization to ensure adequate contamination controls and to minimize the work required to return the area to its normal condition.

14. **At the WVDP:** An effective means of controlling removable radioactive surface contamination is to use enclosures around the contaminated item to keep radioactive material inside. Contamination containments should be used to the maximum extent practicable to control contamination.

15. **At the WVDP:** The use of enclosures allows the reduction of anti-contamination clothing requirements, thereby improving their working efficiency. Yellow polyethylene sheets, yellow plastic bags, or glove-box-style portable containments may be used to enclose contaminated materials to prevent the spread of contamination. The following rules apply to the construction of temporary containment enclosures:

    A. The enclosure shall be fire retardant and shall consist of a fabric adequately supported within a frame or tied off to existing structural members. The fabric should be fire retardant PVC or equivalent. The supporting structure should also be fire retardant.

    B. The enclosure should be complete on all sides and the top, and as nearly air-tight as the situation permits. All seams should be sewn, glued, or sealed.

    C. Care should be exercised to ensure that lights and/or other sources of heat do not contact and/or damage the containment surfaces.

    D. The enclosure should be large enough for proper completion of the job consistent with minimizing the contaminated area.

    E. Transparent windows may be installed to improve interior lighting or to provide visual access.

    F. The enclosure should have at least one inlet filter installed.

    G. Depending upon the anticipated radiological conditions, a high efficiency particulate air (HEPA) filtered exhaust system may be required. This system shall maintain the enclosure atmosphere at a pressure lower than the surrounding area.

    H. Enclosures which are to be used in areas exposed to the weather should be provided with a weather resistant barrier in addition to the above requirements.

    I. Service sleeves should be used during containment construction so that service lines may be routed into the tents, thus allowing closure or sealing the tent. With the proper use of service sleeves, slits should not be cut into the tent.

    J. Yellow containments should not be used for non-radiological work.

16. **At the WVDP**: Equipment and materials shall be adequately monitored and characterized when moved from higher radiological hazard areas to lower radiological hazard areas. Remote monitoring may be used where appropriate.

343 Logs and Communications

1. During continuous or extended daily operations, radiological control personnel should maintain logs to document radiological occurrences, status of work activities, and other relevant information.

2. Oncoming radiological control personnel should review logs and receive a turnover briefing from the personnel they are relieving.

3. Communication systems required by the radiological work permit or technical work document should be checked for operability before being brought into the work area and periodically during work.

4. Workers should keep radiological control personnel informed of the status of work activities that affect radiological conditions.

344 Review of Work in Progress

1. As part of their normal work review, both radiological control and work supervisors should periodically review ongoing jobs to ensure prescribed radiological controls are being implemented.

2. Radiological control personnel should conduct tours of the workplace to review the adequacy of radiological work practices, posting, and area controls.

3. During the performance of jobs for which a pre-job dose estimate was made, the radiological control organization, in cooperation with line management, should periodically monitor collective dose accumulation and compare it with the pre-job dose estimate. Differences should be reviewed to identify causes and assess the need for corrective actions.

345 Stop Radiological Work Authority

1. Radiological control technicians and their supervisors, line supervision, and any worker through their supervisor shall have the authority and responsibility to stop radiological work activities for any of the following reasons [see 10 CFR 851]:

   A. Inadequate radiological controls

   B. Radiological controls not being implemented

   C. Radiological control hold point not being satisfied.

2. Stop radiological work authority should be exercised in a justifiable and responsible manner.

   A. **At the WVDP:** See Article 141 for additional requirements of stop work authority for RCTs.

3. Once radiological work has been stopped, it should not be resumed until proper radiological control has been reestablished.

4. Resumption of work involving radiological hazards should require the approval of the line manager responsible for the work and the radiological control manager or designee.

346 Response to Abnormal Situations

1. The site-specific radiological control manual or procedures for responding to abnormal situations should establish requirements for alarm response. Site alarm response procedures should address the general actions in items 2 through 6 below, modified as necessary to reflect specific facility conditions.

2. Response to a continuous air monitor alarm should include the following actions:

   A. Stop work activities and place the area in a safe condition (i.e., secure welding equipment, terminate activities that may result in more severe conditions)

   B. Exit the area

   C. Notify radiological control personnel.

3. Response to increasing or unanticipated radiation levels, as identified by a supplemental dosimeter or area radiation monitor alarm, should include the following actions:

   A. Stop work activities and place the area in a safe condition (i.e., secure welding equipment, terminate activities that may result in more severe conditions)

   B. Alert others

   C. Affected individuals exit the area

   D. Notify radiological control personnel.

4. Response to a criticality alarm should include the following actions:

   A. Immediately evacuate the area, without stopping to remove protective clothing or perform exit monitoring

   B. Report to designated assembly area.

5. Response to a personnel contamination monitor alarm should include the following actions:

   A. Remain in the immediate area

   B. Notify radiological control personnel

   C. Take actions to minimize cross-contamination, such as putting a glove on a contaminated hand

   D. Take follow-up actions in accordance with Article 541.

6. Response to a spill of radioactive material should include the following actions:

   A. Stop or secure the operation causing the spill

   B. Warn others in the area

   C. Isolate the spill area if possible

   D. Minimize individual exposure and contamination

E. Secure unfiltered ventilation

F. Notify radiological control personnel.

For radioactive spills involving potentially toxic chemicals, workers should immediately exit the area without attempting to stop or secure the spill. They should then promptly notify the Industrial Hygiene or Hazardous Material Team and radiological control personnel.

At the WVDP: The response to a spill of Naturally Occurring Radioactive Material (NORM) or Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) should include the above items 346.6.A through 346.6.F.

7. **At the WVDP**: The WVDP shall establish and maintain plans and procedures for providing resources in response to requests for radiological emergency assistance in accordance with DOE O 153.1. The requirements for the DOE Radiological Assistance program (RAP) shall be implemented and maintained in WVDP-246, "Radiological Assistance Program Plan."

347 Controls for Benchtop Work, Laboratory Fume Hoods, Sample Stations, Glovebags, and Gloveboxes

The following provisions are applicable to radiological work that has the potential to generate radioactive contamination in localized benchtop areas, laboratory fume hoods, sample stations, glovebags, and glovebox operations located in areas that are otherwise contamination free.

1. Provisions for radiological work permits are provided in Article 322.

2. Protective clothing should, at a minimum, include labcoats and gloves. Gloves should be secured at the wrist as necessary to prevent forearm contamination.

3. Shoecovers should be considered based on the potential for floor contamination.

4. Workers should periodically monitor their hands during work, change contaminated gloves and notify the RCO of unexpected levels of contamination.

5. Upon completion of work or prior to leaving the area, workers should monitor those areas of their body that are potentially contaminated. At a minimum, this includes hands, arms, and front portions of the body. A whole body frisk is recommended. If the working area was a contamination area, high contamination area, or airborne radioactivity area, workers shall monitor those areas of heir body that are potentially contaminated [see 835.1102(d)].

6. If there is a potential for splashing or airborne radioactivity, such as when taking pressurized samples, additional controls such as rubber aprons, face shields, full PCs, or respiratory protection should be considered.

7. Gloveboxes should be inspected for integrity and operability prior to use.

8. Gloveboxes should be marked with, or survey measurements should be posted to identify, whole body and extremity dose rates.

   A. **At the WVDP:** Glove boxes shall be labeled with radioactive material tags containing the radiation symbol and the words “Caution Radioactive Material.” If radiation levels exceed preestablished levels as specified in approved written procedures, then a Radiation Work Permit shall be obtained for working with the sample in the glovebox. The Radiation Work Permit shall identify the whole body and extremity dose rates. Otherwise, existing radiation levels shall be

maintained below the preestablished levels which will be noted on the radioactive material tag. *[Article 113]*

9. **At the WVDP:** A large quantity of laboratory radioactive material work is performed within fume hoods which are specifically designed for that purpose (i.e., constructed of stainless steel, ventilated, etc.). Spills of radioactive material which occur within a fume hood are normally contained by the fume hood and should normally empty to the radioactive service drain of the fume hood. For this reason, the following directions should apply to all loss of material containment within radioactive service fume hoods:

   A. For spills or loss of containment of radioactive material within a fume hood, including solutions, powders, and resins that contain or are suspected to contain activity in excess of 1.0×10^{-3} µCi/ml for any radionuclide (gross alpha and gross beta included), **SWIMS** shall be instituted and the Radiation Safety organization notified immediately.

   B. Clean-up operations to restore the fume hood shall be performed per the direction of the Radiation Safety organization.

   C. For all other occurrences, standard precautions for contamination control and remediation shall be instituted.

348 Controls for Hot Particles

Hot particles are small, discrete, highly radioactive particles capable of causing extremely high doses to a localized area in a short period of time. Hot particle contamination may be present or be generated when contaminated systems are opened or when operations such as machining, cutting, or grinding are performed on highly radioactive materials.

1. Where applicable, the site-specific radiological control standard should define hot particles, such as those capable of producing an equivalent dose to the skin greater than 100 millirem in one hour, specific to facility operations and source terms.

   A. **At the WVDP:** Hot particles should be considered as those producing a non-penetrating equivalent dose greater than 100 mrem per hour.

2. Measures for controlling hot particles, as identified in items 3 through 7 of this Article, should be implemented under the following conditions:

   A. Upon identification of hot particles

   B. During new or non-routine operations with a high potential for hot particles, based on previous history

   C. Upon direction of the radiological control organization.

   At the WVDP: The control of Hot Particles is not applicable to the WVDP at this time. If and when systems or processes are started that can potentially generate Hot Particles or when Hot Particles are discovered, Articles 348.2 through 348.7 will be implemented.

3. Survey provisions for areas or operations with the potential for hot particle contamination are established in Article 554.9.

4. Contamination area postings should be annotated to specifically identify the presence of hot particles.

5. Access to hot particle areas should be controlled by an RWP. The following controls should be considered for inclusion on the RWP:

   A. Periodic personnel monitoring during the work activity, at a frequency based on the potential magnitude of personnel exposure

   B. Additional personal protective equipment and clothing

   C. Direct radiological control coverage during work and assistance during protective clothing removal

   D. Use of sticky pads or multiple step-off pads.

6. Personal protective equipment and clothing used in hot particle areas should be segregated from other radiological protective equipment and clothing during laundering and surveyed prior to reuse.

7. Response to hot particle skin or clothing contamination should include the following:

   A. Immediate removal and retention of the hot particle for subsequent analysis

   B. Analysis of the particle

   C. Assessment of worker dose

   D. Evaluation of work control adequacy.

PART 5 Evaluation of Performance

During the conduct of radiological work and the handling of radioactive materials, abnormal events may occur which could indicate a weakness or area of programmatic breakdown of radiological controls. Prompt, consistent gathering of facts related to such events is required to satisfy reporting and investigation requirements and to formulate corrective actions to prevent recurrence. In addition, successful performance or completion of unique activities should be evaluated to identify and incorporate appropriate lessons learned.

Analysis of the facts should reveal areas where improvements can be made or where methods can be identified to prevent the recurrence of undesired results.

351 Conduct of Critiques

Critiques are meetings of the individuals knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts. The purpose of the critique is to establish and record the facts and develop lessons learned. Line management should follow site-specific procedures/guidance for analyzing and reporting events; in cases where site-specific guidance doesn't exist, line management should use the following guidance in a graded approach, consistent with the magnitude or complexity of the event being critiqued.

At the WVDP: Successful events do not require a critique, but may be documented by an ALARA post-job review or a Lessons Learned Bulletin [*Article 113*].

1. Critiques should be conducted for successes and abnormal events.

   A. **At the WVDP:** Abnormal events are evaluated, categorized, investigated, and reported to a three-tier system (per WVDP-242) that uses a graded approach to event investigation and resolution. Upon discovery, an event can be documented by an Issue Report, a Critique, or an Occurrence Report. Successful events do not require a critique, but may be documented by an ALARA post-job review or a Lessons Learned Bulletin [*Article 113*].

2. Critique meetings should be conducted as soon as practicable after the event or situation is stabilized, or after a successful evolution is completed. Critiques of abnormal events should preferably be conducted before involved personnel leave for the day.

   A. **At the WVDP:** Critique minutes are not required to be produced after a successful evolution is completed, but may be documented by an ALARA post-job review or a Lessons Learned Bulletin [*Article 113*].

3. At a minimum, the general critique process should include the following elements:

   A. Formal meetings, chaired by a critique leader

      1. **At the WVDP:** At a minimum, the general critique process should include either: Formal meetings chaired by a member of the Event Investigation Team (EIT) at the request of the facility manager, or an investigation of the event by the EIT investigator to collect pertinent data and information needed to document the results [*Article 113*].

   B. Attendance by all members of the work force who can contribute

   C. Attendance records

   D. Minutes signed by the critique leader

   E. A listing of the facts in chronological order

F. Supporting materials, including documents, records, photographs, parts, and logs, maintained by the critique leader.

G. Lessons learned

4. Evaluation of complex evolutions or events may require multiple critiques.

352 Post-Job Reviews

1. Performance should be reviewed after completion of non-routine radiological work. Requirements for post-job reviews should be delineated in the site-specific radiological control standard.

2. As appropriate to the work in question, post-job reviews should include reviews of:

A. The total and individual doses compared to the pre-job estimates

B. The efficacy of the radiological controls implemented for the work

C. Any adverse events occurring during the work, such as skin contaminations, unexpectedly high individual exposures, or problems resulting from unnecessarily burdensome control requirements

D. Conflicts between radiological safety requirements and other safety requirements

E. Opportunities to improve performance or efficiency during repeated or similar work

F. Significant differences between expected and actual radiological conditions or other issues affecting the work

G. Worker input regarding possible improvements in radiological safety practices for repeated or similar work.

3. **At the WVDP:** Post-job reviews will be conducted for all radiological work activities that were estimated or actually exceeded the trigger levels established in Article 312.3. Post-job reviews shall also be conducted following the completion of complex radiological work activities.

4. **At the WVDP:** Post-job reviews are prepared by the cognizant work supervisor(s) and documented.

5. **At the WVDP:** The post-job review should compare the actual person-hours and person-rem with the estimates, evaluate the effectiveness of the ALARA controls, document the lessons learned, and make recommendations to reduce dose for similar activities.

353 Lessons Learned

Lessons learned are available from post-job reviews and reports of past radiological events on site and at other facilities. The radiological control organization, in conjunction with line management, should evaluate lessons learned, provide prompt distribution, and incorporate the lessons into the site radiological control program, the radiological control training program, and related operations, as deemed appropriate by the RCO.

PART 6 Special Applications

This Part provides supplemental information to augment the basic provisions of the Standard. Articles 361 through 365 provide information to be used in developing the site-specific radiological control standard. Written guidance and requirements contained within DOE documents, consensus standards, or Federal regulations that delineate specifics for each application are referenced.

Articles 361 through 363 of this Part are applicable to those facilities where the majority of the work or operations involve the subject radionuclide as the significant source term. This Part is not intended to apply to facilities that use the subject radionuclides in limited or tracer amounts, such as analytical laboratories.

361 Plutonium Operations

Low levels of plutonium in the body are difficult to measure and biological removal processes for plutonium are slow. For this reason:

Primary emphasis shall be placed on engineered features to contain plutonium and to prevent airborne and surface contamination [see 835.1001(a)].

Methods should be established to allow for the discrimination of background activity from air-monitoring and sampling results in a timely fashion.

Additional information is found in DOE-STD-1128-98.

362 Uranium Operations

Natural, depleted, and low-enriched uranium are unusual in that their chemical toxicity in the human body (i.e., the potential to cause kidney damage) is generally of greater concern than their radioactivity Also, processed uranium sometimes contains transuranic and other radionuclides from recycled materials.

Additional information can be found in DOE-STD-1136-2004.

363 Tritium Operations

The following characteristics of tritium require consideration in the implementation of the radiological control program at tritium facilities:

1. Tritium emits low energy beta particles which cannot be monitored using external dosimeters, consequently requiring the use of bioassay measurements to evaluate worker dose.

2. Worker exposure to tritium as water vapor causes a much greater dose than exposure to elemental tritium gas.

3. Normal personnel frisking techniques are ineffective for tritium. Consequently, a high reliance is placed on worker bioassay and routine contamination and air monitoring programs.

4. Due to its ability to permeate substances which it contacts, including human skin, tritium is difficult to contain. Special attention should be directed to the selection of personal protective equipment and clothing.

For the above reasons, guidance contained in DOE-HDBK-1129-2008, Tritium Handling and Safe Storage, should be considered in preparing the site-specific radiological control standard for tritium operations. This handbook provides specific guidance related to internal dosimetry, contamination and air monitoring, special tritiated

compounds (STCs), training, tritium containment practices and techniques, and personal protective equipment and clothing selection.

364 Accelerator Operations

Special considerations associated with accelerator facilities include the presence of extremely high dose rates, the generation of activation products, and detection and monitoring difficulties associated with pulsed or high energy radiation. For these reasons:

1. In addition to the provisions of this Standard, guidance contained in the document, DOE-HDBK-1108-2002, Radiological Safety Training for Accelerator Facilities, should be considered in preparing the site-specific radiological control standard for accelerator operations. This standard provides specific guidance related to radiological monitoring, dosimetry, shielding design, use of interlocks, and procedures and administrative controls.

2. Consideration should be given to the information provided in DOE O 420.2B, Safety of Accelerator Facilities, in preparing the site-specific radiological control standard.

3. Safety devices and interlocks that are necessary to meet the high radiation area control requirements of 10 CFR 835.501 shall be operational prior to and during operation of a beam [see 835.501(b)]. Operational status should be verified by testing. Safety devices and interlocks should be fail-safe.

4. **At the WVDP:** Accelerator operation requirements are not applicable.

365 Radiation Generating Devices

Special considerations associated with the use of radiation generating devices include the presence of extremely high dose rates and the potential for uncontrolled exposures. Operation of these devices requires stringent physical and administrative controls to prevent overexposure to operating and support personnel and those in adjacent work areas. The following procedures should be considered when developing site-specific procedures for applicable types of radiation generating devices:

1. ANSI N43.3, American National Standard for General Radiation Safety-Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, establishes acceptable guidelines for operations involving the irradiation of materials.

2. ANSI N43.2, Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment, provides guidelines for operations involving the following devices:

   A. Analytical diffraction and fluorescence

   B. Flash X-ray

   C. Sealed source irradiators used for diffraction studies.

3. Line management, in conjunction with the radiological control organization, should establish the radiological control requirements for incidental X-ray devices such as electron microscopes and electron beam welders.

4. Devices for medical use should be registered with the appropriate regulatory agency.

5. Control requirements for radiographic devices include the following:

A. Title 10 CFR 34, Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations establishes acceptable guidelines for operations with devices containing sealed sources.

B. ANSI/HPS N43.3-2008: For General Radiation Safety - Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, establishes acceptable guidelines for on-site operations with devices other than sealed sources for radiographic use.

C. On-site operations conducted by off-site contractors should be approved by line management in coordination with the site radiological control organization. This process should ensure the contractor has a valid Nuclear Regulatory Commission or Agreement State license and that the operational and emergency procedures are current and available.

6. Safety devices and interlocks at fixed installations that are required to ensure compliance with 10 CFR 835.501 shall be operational prior to and during generation of a radiation field. Operational status should be periodically verified by testing. Safety devices and interlocks should be fail-safe.

7. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C," Radiation Protection Programs Guide."

8. **At the WVDP:** The Radiation Safety organization, and other departments as necessary, shall be notified of all construction contractor radiography operations conducted in WVDP facilities.

A. This notification shall be made 24-hours prior to the initiation of radiography operations and shall be made at the start of each work shift during which the radiography operations are to be conducted.

B. An RWP is required for radiography operations at WVDP.

C. All radiography operations shall be continuously monitored by a qualified RCT.

9. **At the WVDP:** Prior approval of the radiography operations and radiography control procedures, submitted by the radiographer, shall be required.

A. The Radiation Safety organization shall concur with the adequacy of the radiological control measures instituted. In general, this concurrence shall concern area posting, demarcation, surveillance measures, and operator and equipment qualifications.

B. The demarcation, posting, and surveillance measures shall address unshielded or inadequately shielded areas adjacent to the area in which the radiography work will occur so that appropriate barriers and posting can be established in these areas.

C. The Radiation Safety organization shall also be satisfied with the adequacy of the radiation detection instrumentation and dosimetry utilized by the radiographer.

10. **At the WVDP:** X-ray and Radiography Training Requirements:

A. Off-site operators of X-ray and radiographic equipment should have certifications and proof of training, as appropriate, commensurate with NCRP Publication No. 61.

B. Supervisors and operators of X-ray and radiography equipment shall be thoroughly trained in the safe operation and emergency procedures of the machines they are using as well as be WVDP qualified Radiological Workers.

C. Radiographers and radiographers assistants shall receive a documented review of the WVDP requirements pertaining to radiography operations.

11. **At the WVDP:** Requirements for X-ray and Radiography Equipment:

A. Inspection stickers shall be affixed to each X-ray and radiography machine showing the date of the last check. Detailed and auditable records shall be kept of all inspections of X-ray and radiography equipment.

B. All X-ray and radiography equipment shall be protected from unauthorized use by a locking device, preferably a key switch from which the key can only be removed when in the "off" position. Unattended equipment should always be located within a locked area.

C. The radiographer shall have at least one operational radiation survey instrument, calibrated within the previous three (3) months, and appropriate for the type of radiation being used available at the location of any X-ray or radiography operation. The survey instrument shall be source-checked before use and shall be capable of registering from two (2) mR/hr up to one (1) R/hr.

D. Radiographic exposure devices, storage containers, and source changers shall be checked for obvious defects prior to use each day. Inspection and maintenance of industrial and research X-ray and radiography machines, storage containers, and source changers shall be conducted within three months before use to assure proper safety function. Defects or impaired function of components vital to safety should be identified, reported, and corrected prior to continued use.

E. X-ray and radiography equipment which is "on" shall not be left unattended except under emergency procedural control. Radiography sources shall be secured or locked in the radiographic exposure device after each source retraction. Assurance of this action shall be obtained by use of a key lock or other mechanical device providing a positive indication that the source has been fully retracted.

12. **At the WVDP:** All X-ray and radiography operators shall wear supplemental dosimetry and TLD badges, which includes an audible alarming dosimeter, while performing radiographic operations.

13. **At the WVDP:** Detailed radiation surveys and safety checks shall be initially accomplished for each different location before installation and/or use of X-ray or radiography equipment.

14. **At the WVDP:** Radiation warning placards and barriers as required by Article 250 should be in place and visible from all avenues of approach before use of the X-ray and radiography equipment. For radiography conducted in the field, all reasonable means, including visual surveillance and audible announcement shall be taken to ensure the affected area is evacuated of unauthorized personnel.

15. **At the WVDP:** In addition to any permanent instrumentation, entry into an enclosure or cell in which radiographic operations are established also requires the use of a properly calibrated hand held radiation detection instrument. The operators shall be briefed as to radiological conditions by the RCT, prior to operation of any equipment.

16. **At the WVDP:** The field work site or the permanent installation shall be surveyed with a properly calibrated radiation survey instrument after each radiographic exposure to determine that the radiation source has been de-energized or returned to a shielded position. The entire circumference of the radiographic exposure device shall be surveyed. If the radiographic exposure device has a source guide tube, the survey shall include the guide tube.

17. **At the WVDP:** Emergency procedures shall be developed to define the immediate actions to be taken by radiography personnel in the event of a lost source, actual or perceived equipment malfunction, an off-scale monitor or pocket dosimeter, or other unexpected occurrence. Emphasis should be placed on the performance of radiation survey instruments, self-reading dosimeters, and radiography equipment which affect source control.

PART 7 [Reserved]

Part 8 Design and Control

381 Radiological Design Criteria

The following design objectives are applicable during the design of new facilities and modification of existing facilities. Additional design criteria are provided in DOE Order 420.1.

NOTE: At the WVDP: DOE Order 420.1 has been superceded by DOE Order 420.1A.

1. For areas of continuous occupancy (2000 hours per year), the design objective shall be to maintain the average exposure level ALARA and below 0.5 millirem per hour. If occupancy is not continuous, the design objective shall be to maintain doses ALARA and below 20% of the occupational dose limits provided in Table 2-1 [see 835.1002(b)].

2. For control of airborne radioactivity, the design objective shall be to avoid releases to the work place atmosphere under normal conditions and, under any conditions, to control inhalation by workers to levels that are ALARA. Confinement and ventilation shall normally be used [see 835.1002(c)].

3. For materials used in facility construction and modification, the design objective shall be to select materials that facilitate operations, maintenance, decontamination, and decommissioning [see 835.1002(d)]. Components should be selected to minimize the buildup of radioactivity. Control of surface contamination should be achieved by containment of radioactive material.

4. In justifying facility design and physical controls, optimization methods shall be used [see 835.1002(a)].

5. Support facilities should be provided for donning and removal of protective clothing and for personnel monitoring, when required.

6. A neutron radiation weighting factor of 20 for conditions of unknown spectra, for design purposes, is consistent with the most limiting neutron radiation weighting factor found in 10 CFR 835.2.

7. Existing facility designs that have office space and lunchrooms or eating areas within radiological areas, require priority attention. Generally:

   A. Locating lunch rooms or eating areas, restrooms, drinking fountains, showers and similar facilities and devices is strongly discouraged within these areas

   B. Locating office spaces within these areas is strongly discouraged; to the extent that such space is essential to support radiological work, steps should be taken to preclude unnecessary occupancy.

8. Facilities currently under construction should be evaluated and the above criteria applied where practicable.

9. See Standard STD-1189-2008, Integration of Safety into the Design Process, for information on the procedures required for design of new nuclear facilities or major modifications of other facilities.

10. To ensure adequate protection of the work force, planning for radiological work should also include consideration of all other workplace hazards (e.g., industrial hygiene, chemical safety, fire safety, electrical safety, etc.), consistent with the principles of Integrated Safety Management as discussed in Article 118 and as required by 10 CFR 851, Worker Safety and Health Program.

11. **At the WVDP:** Designs for a new facility or modification of an existing facility shall be performed in accordance with the following requirements:

A. Designs should incorporate radiological considerations in the early planning stages. The checklist provided in Appendix 3F is helpful in reviewing designs for ALARA and radiological considerations.

B. Designs with the potential to exceed the following trigger levels shall undergo a formal, documented ALARA design review:

1. Creation of a new radiation source or an increase in the dose rate from an existing radiation source that exceeds 50 percent of the design objectives provided in 10 CFR 835.1002(b) and Article 381.1. This also includes the relocation of personnel to areas with dose rates exceeding this criteria.

2. An increase greater than 100 person-hours per year to operations, maintenance, production, research, inspection, or decommissioning personnel in a High Contamination Area.

3. Projected expenditure of a collective dose greater than 1000 person-mrem per year to the workforce occupying or affected by the new or modified facility.

4. When directed by the Radiation Safety Manager.

C. Optimization techniques shall be an intrinsic part of the engineering review process, as discussed in Article 312.8. A formal, documented optimization or cost-benefit analysis, as required by 10 CFR 835.1002(a) and Article 381.4, shall be performed by the design originator, assisted by the Radiation Safety organization, if any trigger level presented in Article 381.11.B is predicted or expected to be exceeded and when identified by the formal ALARA design review.

382 Control Procedures

1. Administrative control and procedural requirements shall be developed and implemented as necessary to supplement facility design features, particularly when the design of existing facilities is not in accordance with current standards [see 835.1001(b)]. Administrative control procedures include access control measures, RWPs, and technical work documents as discussed in this Standard.

2. Written procedures shall be developed as necessary to ensure compliance with the provisions of this Standard that are derived from 10 CFR 835 [see 835.104]. These procedures shall be commensurate with the radiological hazards created by the activity and the education, training, and skills of the individuals who are exposed to these hazards [see 835.104].

3. Written authorizations, including specific radiation protection measures, shall be required to control entry into and work within radiological areas [see 835.501(d)]. These authorizations may include RWPs, technical work documents, administrative procedures, and other administrative controls.

4. The combination of engineered controls and administrative control procedures shall be sufficient to ensure that, during routine operation, the Table 2-1 dose limits for general employees are met and to ensure doses are ALARA [see 835.1003(a)].

Appendix 3A. Checklist for Reducing Occupational Radiation Exposure

Preliminary Planning and Scheduling

The following elements should be considered, as applicable, during the preliminary planning and scheduling of work.

- Plan in advance
- Delete unnecessary work
- Determine expected radiation levels
- Estimate collective dose
- Sequence jobs
- Schedule work
- Select a trained and experienced work force
- Identify and coordinate resource requirements

Preparation of Technical Work Documents

- Include special radiological control requirements in technical work documents
- Perform ALARA pre-job review
- Select and optimize engineering and administrative controls to control doses
- Plan access to and exit from the work area
- Provide for service lines (air, welding, ventilation)
- Provide communication (sometimes includes closed-circuit television)
- Remove or shield sources of radiation
- Plan for installation of temporary shielding
- Decontaminate
- Work in lowest radiation levels
- Perform as much work as practicable outside radiological areas
- State requirements for standard tools
- Consider special tools, including robots
- State staging requirements for materials, parts and tools
- Incorporate radiological control hold points
- Analyze PPE requirements to ensure optimization of hazard control, risks, and costs
- Minimize discomfort of workers
- Revise estimates of collective dose
- Prepare radiological work permits (RWPs)

Temporary Shielding

If temporary shielding is needed to prevent exposure to high radiation areas, the line organization and the RCO should consider the following in the development of the work package.

- Design shielding to include stress considerations
- Control installation and removal by written procedure
- Inspect after installation
- Conduct periodic radiation surveys
- Prevent damage caused by weight of heavy temporary shielding
- Balance radiation exposure received in installation against exposure saved by installation
- Shield travel routes
- Shield components with abnormally high radiation levels early in the maintenance period

Appendix 3A
(continued)
Checklist for Reducing Occupational Radiation Exposure

Temporary Shielding (continued)

- Shield position(s) occupied by worker
- Perform directional surveys to improve design of shielding by locating source of radiation
- Use mock-ups to plan temporary shielding design and installation
- Consider use of water-filled shielding

Rehearsing and Briefing

When high-consequence work is to be performed, line management and the RCO should consider including the following elements in the work planning.

- Rehearse
- Use mock-ups duplicating working conditions
- Use photographs and videotapes
- Conduct briefings of workers in accordance with Article 324

Performing Work

Line management and the RCO should consider incorporating the following elements, as applicable, into the conduct of operations.

- Comply with technical work documents and RWPs
- Post radiation levels
- Keep excess personnel out of radiation areas
- Control radiation exposure while controlling exposure to other hazards
- Supervisors and workers keep track of radiation exposure
- Compare actual dose against pre-job estimates
- Workers assist in radiation and radioactivity measurements
- Delegate radiological control monitoring responsibilities
- Evaluate the size of the work crew as work progresses
- Reevaluate methods used to control radiation doses
- Compare actual collective dose against pre-job estimate
- Coordinate personnel at the job site to reduce non-productive time

Appendix 3B. Physical Access Controls for High and Very High Radiation Areas

1. One or more of the following features should be used for each entrance or access point to a high radiation area and shall be used for each entrance or access point to a high radiation area where radiation levels exist such that an individual could exceed a whole body dose of 1 rem in any one hour [see 835.502(b)]:

   A. A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a high radiation area

   B. A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area

   C. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry

   D. Entryways that are locked, except during periods when access to the area is required, with positive control over each entry

   E. Continuous direct or electronic surveillance that is capable of preventing unauthorized entry

   F. A control device that automatically generates audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

2. In addition to the above requirements, additional measures shall be implemented to ensure individuals are not able to gain access to very high radiation areas when dose rates are in excess of the posting requirements of Table 2-3 [see 835.502(c)].

3. Physical access controls over high and very high radiation areas shall be established in a manner that does not prevent an individual from leaving the area [see 835.502(d)].

Appendix 3C. Contamination Control Practices

Selection of Protective Clothing (PC)

1. Workers should inspect protective clothing prior to use for tears, holes, or split seams that would diminish protection. Any defective items should be replaced with intact protective clothing.

2. Protective clothing as prescribed by the radiological work permit should be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, area(s) of the body likely to be exposed to removable contamination, and regard for non-radiological hazards that may be present. Table 3-1 provides general guidelines for selection. As referenced in the table, a full set and double set of protective clothing typically includes:

   Full Set of PCs

   A. Coveralls
   B. Cotton glove liners (optional)
   C. Gloves
   D. Shoe covers
   E. Rubber overshoes (optional)
   F. Hood

   Double Set of PCs

   A. Two pairs of coveralls
   B. Cotton glove liners (optional)
   C. Two pairs of gloves
   D. Two pairs of shoe covers
   E. Rubber overshoes (optional)
   F. Hood

3. Cotton glove liners may be worn inside standard gloves for comfort, but should not be worn alone or considered as a layer of protection.

4. Shoecovers and gloves should be sufficiently durable for the intended use. Leather or canvas work gloves should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.

5. Use of industrial safety equipment, such as hard hats, in contamination, high contamination, and airborne radioactivity areas should be controlled by the radiological work permit. Reusable industrial safety equipment designated for use in such areas should be distinctly colored or marked.

   A. **At the WVDP:** Use of hard hats in Contamination Areas are designated on Industrial Work Permits [*Article 113*].

6. Shoe covers and gloves should be secured or taped at the coverall legs and sleeves when necessary to prevent worker contamination. Tape should be tabbed to permit easy removal.

7. Supplemental pocket or electronic dosimeters should be worn outside the protective clothing, in a manner accessible to the worker. Workers should protect such dosimeters from contamination by placing them in an outer coverall pocket or in plastic bags or pouches.

Appendix 3C
(continued)
Contamination Control Practices

8. Outer personal clothing should not be worn under protective clothing for entry to high contamination areas or during work conditions requiring a double set of protective clothing.

9. **At the WVDP:** Anti-contamination clothing, as specified by the Radiation Safety organization, shall be worn when either removable contamination or airborne radioactivity may exceed allowable limits as set forth in Articles 222 and 223 respectively.

10. **At the WVDP:** The need for anti-contamination clothing shall be evaluated for each operation by the Radiation Safety organization. Special requirements may be initiated in the individual standard operating procedure, special instruction procedure, Work Instruction Package, or procedures written for situations which differ from the normal method.

11. **At the WVDP:** Anti-contamination clothing is any clothing worn to protect personnel from radioactive contamination. This clothing consists of, but is not limited to, coveralls, shoe covers, rubbers, gloves, hoods and respiratory protective equipment. Plant issued work coveralls (e.g., WVDP blue or tan coveralls) are not considered anti-contamination clothing.

12. **At the WVDP:** Donning and doffing anti-contamination clothing and setting up control points has been established in standard operating procedure (SOP). The SOP shall be maintained by the radiological control organization to incorporate changes in general requirements for work in contaminated areas [*Article 113*].

Removal of Protective Clothing

Potentially contaminated protective clothing should be removed without spreading contamination and in particular without contaminating the skin. Workers should be instructed not to touch the skin or place anything in the mouth during protective clothing removal.

Recommended Sequence for Removing a Full Set of Protective Clothing at the Step-Off Pad

Before stepping out of the contamination area or airborne radioactivity area to the step-off pad, the worker should:

1. Remove exposed tape
2. Remove rubber overshoes
3. Remove gloves (Remove potentially contaminated gloves; replace with 'clean' gloves if a second glove was not originally worn.)
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove coveralls, inside out, touching inside only
7. Take down barrier closure, as applicable
8. Remove tape or fastener from inner shoe cover
9. Remove each shoe cover, placing shoe onto clean step-off pad
10. Remove cloth glove liners
11. Replace barrier closure, as applicable
12. Commence whole body frisking
13. Monitor badge and dosimeter.

Appendix 3C
(continued)
Contamination Control Practices

The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination. The sequence for removal of respiratory protection devices may be altered if it is determined that the potential for inhalation of airborne contamination or the spread of surface contamination is reduced by keeping respiratory protection devices on until all protective garments have been removed.

At the WVDP: The procedure for doffong anti-contamination clothing has been established in an SOP. The removal of anti-contamination clothing should comply with the SOP which shall be maintained or caused to be maintained by the radiological control organization [*Article 113*].

Recommended Sequence for Removing a Double Set of Protective Clothing Using Two Step-Off Pads

Before stepping to the inner step-off pad, the worker should:

1. Remove exposed tape
2. Remove rubber overshoes
3. Remover outer gloves
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove outer coverall, inside out, touching inside only
7. Remove tape from inner coverall and sleeves
8. Remove each outer shoe cover, stepping on inner step-off pad as each is removed.

Before stepping to the outer step-off pad, the worker should:

9. Remove inner rubber gloves
10. Remove inner coveralls, inside out, touching inside only
11. Take down barrier closure, as applicable
12. Remove tape or fastener from inner shoe cover
13. Remove each inner shoe cover, placing shoe on clean outer step-off pad
14. Remove cotton glove liners
15. Replace barrier closure, as applicable
16. Commence whole body frisking
17. Monitor badge and dosimeter.

The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination. The sequence for removal of respiratory protection devices may be altered if it is determined that the potential for inhalation of airborne contamination or the spread of surface contamination is reduced by keeping respiratory protection devices on until all protective garments have been removed.

Appendix 3C
(continued)
Contamination Control Practices

Use of Multiple Step-Off Pads

1. Multiple step-off pads should be used to control exit from high contamination areas. These pads define interim control measures within the posted area to limit the spread of contamination. The following controls apply:

   A. The inner step-off pad should be located immediately outside the highly contaminated work area, but still within the posted area

   B. The worker should remove highly contaminated outer clothing prior to stepping on the inner step-off pad

   C. Additional secondary step-off pads, still within the posted area, may be utilized as necessary to restrict the spread of contamination out of the immediate area

   D. The final or outer step-off pad should be located immediately outside the contamination area.

Table 3-2 Guidelines for Selecting Protective Clothing (PC)

	REMOVABLE CONTAMINATION LEVELS		
	LOW (1 to 10 times Table 2-2 values)	**MODERATE** (10 to 100 times Table 2-2 values)	**HIGH** (> 100 times Table 2-2 values)
WORK ACTIVITY	**RECOMMENDED PROTECTIVE CLOTHING**		
Routine	Full set of PCs	Full set of PCs	Full set of PCs, double gloves, double shoecovers
Heavy work	Full set of PCs, work gloves	Double set of PCs, work gloves	Double set of PCs, work gloves
Work with pressurized or large volume liquids, closed system breach	Full set of non-permeable PCs	Double set of PCs (outer set non-permeable), rubber boots	Double set of PCs and non-permeable outer clothing, rubber boots

Note:

The RCO may increase or decrease the level of PCs needed depending on the type, level, and extent of contamination, the work to be done, and other non-radiological considerations.

For hands-off tours or inspections in areas with removable contamination at levels 1 to 10 times the values in Table 2-2, labcoats, shoecovers, and gloves may be used instead of full PCs

Appendix 3D. Guidelines for Personnel Contamination Monitoring with Hand-Held Instruments

General Requirements

The RCO may modify the following guidelines, as appropriate to the actual conditions.

1. Verify that the instrument is in service, has a valid source check, is set to the proper scale, and the audio output can be heard during frisking.

2. Hold probe less than 1/2 inch from surface being surveyed for beta and gamma contamination, approximately 1/4 inch for alpha contamination.

3. Move probe slowly over surface, approximately 2 inches per second.

4. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for instrument response.

5. If the count rate increases to a value greater than a preestablished contamination limit or the instrument alarms, remain in the area and notify radiological control personnel.

6. The whole body frisk should take at least two to three minutes.

Performance of Monitoring:

The RCO may modify the following guidelines, as appropriate to the actual conditions.

1. Frisk the hands before picking up the probe.

2. Perform the frisk in the following order:

   A. Head (pause at mouth and nose for approximately 5 seconds)

   B. Neck and shoulders

   C. Arms (pause at each elbow for approximately 5 seconds)

   D. Chest and abdomen

   E. Back, hips and seat of pants

   F. Legs (pause at each knee for approximately 5 seconds)

   G. Shoe tops

   H. Shoe bottoms (pause at sole and heel for approximately 5 seconds)

   I. Personnel and supplemental dosimeters.

3. Return the probe to its holder and leave the area. The probe should be placed on the side or face up to allow the next individual to monitor his/her hands before handling the probe.

Appendix 3E. Radiological Control Limiting Conditions

The RCO may modify the following guidelines, as appropriate to the actual conditions.
The following are examples of limiting radiological conditions which, if encountered, would require action, such as stop work.

Dose and dose-rate

Whole body dose to any individual:

- Where the expected dose is ≤ 50 millirem, consideration may be given to using a limiting radiological condition of 25 mrem greater than expected dose.
- Where the expected dose is > 50 and < 200 millirem, consideration may be given to using a limiting radiological condition of 1.5 times the expected dose.
- Where the expected dose is ≥ 200 millirem, consideration may be given to using a limiting radiological condition equal to the expected dose plus 100 mrem.

> Note: These criteria are typically established for doses received over a short time period (up to several days). For long term activities, periodic ALARA reviews should be sufficient to identify significantly higher than anticipated doses and result in commensurate corrective actions.

For example:

Expected dose (millirem)	Limiting radiological condition (millirem)
10	35
100	150
200	300
800	900

Appendix 3E. Radiological Control Limiting Conditions (Continued)

Whole body dose rate at the worker location:

- Where the expected dose rate is between 5 and 40 millirem/hr, consideration may be given to using a limiting radiological condition of 3 times the expected dose rate.
- Where the expected dose rate is from 40 to 100 millirem/hr, consideration may be given to using a limiting radiological condition of 2 times the expected dose rate.
- Where the expected dose rate is ≥ 100 millirem/hr, consideration may be given to using a limiting radiological condition equal to 1.5 times the expected dose rate, provided that the limiting condition does not exceed the expected dose rate by more than 1,000 mrem.

  Note: The period of time when individuals are in the area with elevated doses rates should also be considered, e.g., very short time periods in some of these areas may not justify stopping the work.
- In addition to the above, a limiting radiological condition should be set upon encountering unexpected radiation levels which change the radiological classification of the area, e.g., a radiation area becomes a high radiation area.

For example:

Expected dose rate (millirem/hr)	limiting radiological condition (millirem/hr)
<1	5 (change in classification)
20	60
40	80
300	450
2,500	3,500

Extremity dose rate:

- Where the expected dose rate is < 1,000 millirem/hr, consideration may be given to using a limiting radiological condition of at least 100 millirem/hr and equal to 2 times the expected dose rate.
- Where the expected dose rate is ≥ 1,000 millirem/hr, consideration may be given to using a limiting radiological condition equal to 1.5 times the expected dose rate, provided that the limiting condition does not exceed the expected dose rate by more than 10,000 mrem.

For example:

Expected dose rate (millirem/hr)	Limiting radiological condition (millirem/hr)
150	300
3,000	4,500
30,000	40,000

Appendix 3E. Radiological Control Limiting Conditions (Continued)

Removable contamination levels

- A limiting radiological condition should be set upon encountering unexpected contamination levels which; change the radiological classification of the area (e.g., a contamination area becomes a high contamination area), or indicate that the contamination monitoring or controls in place must be revised or the protective clothing must be upgraded.

For example:

Expected beta/gamma removable contamination (dpm/100 cm^2)	Limiting radiological condition (dpm/100 cm^2)
< detectable	1000 (change in classification)

Airborne concentrations

- Where the expected airborne levels are ≤ 10 times the 10 CFR 835 Appendix A values, consideration may be given to using a limiting radiological condition of at least the 10 CFR 835 Appendix A value and 3 times greater than expected.
- Where the expected airborne levels are ≥ 10 and < 50 times the 10 CFR 835 Appendix A values, consideration may be given to using a limiting radiological condition of 2 times greater than expected.
- Where the expected airborne levels are ≥ 50 times the 10 CFR 835 Appendix A values, consideration may be given to using a limiting radiological condition of 1.5 times greater than expected.
- In addition to the above, a limiting radiological condition should be set upon encountering unexpected airborne levels which change the radiological classification of the area, e.g., an area becomes classified as an airborne radioactivity area or which indicate that the respiratory protection must be upgraded.

For example:

Expected airborne levels (multiples of Appendix A)	Limiting radiological condition (multiples of Appendix A)
< 0.1	1
5	15
30	60
80	120

Appendix 3F. Checklist for ALARA Design Review

Part 1

DOES THE FACILITY, SYSTEM, OR SUBJECT INVOLVE(*):

1. Entry into or activity in or near a Radiological Area?
2. Shielding; penetrations; equipment separation or segregation; or routing of pipes, conduit, or ducts?
3. Location of sensors, readouts, or like manual-access or visual-access components in a Radiological Area?
4. Activities which may affect ventilation equipment (such as selection and maintenance), produce airborne contamination, or other require local ventilation or airborne controls?
5. Construction or assembly techniques, materials, shapes, flow patterns, or choices of equipment which potentially contribute to crud or other radioactivity production or accumulation?
6. Flow paths or contact surfaces which might require isolation or decontamination, or measures to facilitate decontamination?
7. Radiation monitoring or sampling systems, or modifications which may result in the need to alter or add such systems?
8. Radwaste collecting or processing systems, or modifications which will result in additional radwaste or different forms of radwaste being sent to these systems?
9. Access, laydown, or storage space for installation, removal, maintenance, inspection, or calibration?
10. Lighting, access sizing, noise levels, communications, signaling, labeling, or other human factor considerations?
11. Component or design features that may cause significant radiation exposures during installation, removal, maintenance, or operation, or measures to reduce such exposures?
12. Component or design features that may cause a significant change in the dose to the public, whether by direct radiation or by releases to the environment?

(*) If the answer to any of the above questions is "yes", then continue to Part 2 section(s) that corresponds (by number) to the screening question (i.e., question #3 corresponds to Section 3).

Part 2

Detailed Checklist For ALARA Design Review

SECTION 1 - Access Control and Radiological Boundaries
(to be completed if the answer to question 1 in Part 1 is "yes")

1.1 Have the contained, contamination, and airborne radioactivity sources for the area been determined for the relevant normal, shutdown, and abnormal conditions?
1.2 Have radiological area designations been specified appropriately for the expected dose rates, contamination levels, and occupancies?
1.3 Has access control of areas, rooms, or building been provided for in their design or modification appropriate for their intended use?
1.4 Has appropriate access control been considered during construction or modification of areas, rooms, or buildings?
1.5 Have delivery routes and loading or delivery areas been considered and established for all inside and outside areas, all rooms, and all buildings?
1.6 Has positive physical control been provided as required for each type of Radiological Area?
1.7 Has an optimization analysis been performed, where appropriate?

SECTION 2 - Shielding, Geometry, Separation, Segregation, and Routing
(to be completed if the answer to question 2 in Part 1 is "yes")

2.1 Are shields (of whatever extent or type) of a size and thickness sufficient to meet occupancy requirements outside them, based on conservative source, use occupancy, and layout assumptions?
2.2 Are shield material(s) appropriate for all types of radiation which they are to shield against?
2.3 Have labyrinths, labyrinth roofs, shield doors, and shield plugs or hatches been included as appropriate?
2.4 Have scatter, bremsstrahlung, activation radiation, cascade radiation, etc., from equipment, walls, floor, and ceilings been considered?
2.5 Have penetrations been sized and located to minimize streaming?
2.6 Have penetrations in shielding walls been located and oriented so that accessible areas or radiation sensitive components are not in the streaming path?
2.7 Has streaming through penetrations for pipes, conduits, ducts, etc., been reduced where appropriate by using shadow shields or shield plugs or by filling the void space in these penetrations?

Appendix 3F
(continued)
Checklist for ALARA Design Review
Part 2

2.8 Has local shielding been considered where possible (e.g., temporary shielding, shadow shield, shield caps and covers)?
2.9 Where appropriate, are walls, ceilings, pipe hangers, and components designed to support temporary shielding?
2.10 If shielding is impractical, can distance be used to reduce exposure?
2.11 Are pieces of equipment, potentially producing high dose rates or contamination levels, separated by shielding and distance from each other, from equipment producing low dose rates, and from general access areas?
2.12 Are passive pieces of equipment, requiring little maintenance, placed in the least accessible areas and separated by shielding from equipment requiring frequent maintenance and placed in the most accessible areas?
2.13 In particular, are valves separated in shielded galleries or aisles from high activity equipment?
2.14 If pipes, conduits, or ducts passing through a room might cause a high dose rate in the room when access is required, has relocating them or providing shielding for them been considered?
2.15 Has consideration been given to routing pipes, conduits, and ducts through labyrinths; locating radioactive pipes or other components behind columns; and embedding radioactive pipes in floors when appropriate?
2.16 Has consideration been given to skid mounted systems with shielding or space to add shielding and to separate components producing high dose rates from each other and from less radioactive components?
2.17 Has provision been made for transporting radioactive sources such as samples, filters, etc., by the use of shielding pigs or casks?

SECTION 3 - Instrumentation and Controls
(to be completed if the answer to question 3 in Part 1 is "yes")

3.1 Have readouts or control points for instruments and controllers been located in low dose rate areas?
3.2 Are reach rods or remote operators used for valves which are located in high dose rate areas?
3.3 Are manual valve operators used only for infrequently operated valves or those handling only low levels of radioactivity?
3.4 Are instruments and controls testable, with convenient connections provided for all required tests?
3.5 Do the instruments selected contain the minimum amounts of contaminated working fluid?
3.6 Where appropriate, have instrument systems using an intermediate clean fluid or separation of the instrument internals from the contaminated fluid been considered?
3.7 Are local indicators designed and located so as to be readable from the entry or outside of the corresponding high dose rate cubicle or area, perhaps by the use of mirrors or shield windows?
3.8 Is this an application which would justify the use of a leaded glass window, closed-circuit TV system or the like, or provision for their addition in the future?
3.9 Have alarms, interlocks, manual stops, emergency switches, and overrides been provided as necessary?

SECTION 4 - Control of Gaseous and Airborne Radioactivity
(to be completed if the answer to question 4 in Part 1 is "yes")

4.1 Does ventilation from areas of lower potential airborne activity flow to areas of higher potential activity?
4.2 Is air supplied to areas of lower potential airborne activity and exhausted from areas of higher potential activity?
4.3 Are ventilation supply points located above the worker or work area and away from the sources of contamination, or otherwise placed as appropriate for the work activity (e.g., for work tables, glove boxes, and hoods)?
4.4 Are ventilation exhausts located near the floor and away from entrances or openings to clean areas, or otherwise placed as appropriate for the work activity (e.g., for work tables, glove boxes, and hoods)?
4.5 Has the drawing or exhausting of potentially contaminated air across walkways and work areas been avoided?
4.6 Is ventilation flow sufficient to keep airborne radioactivity concentrations below prescribed levels?
4.7 Are all ducts carrying clean air operated at positive/pressure if they pass through any area of potential airborne contamination?
4.8 Are all ducts carrying potentially contaminated air operated at negative pressure when they pass through clean areas?

Appendix 3F
(continued)
Checklist for ALARA Design Review
Part 2

SECTION 4 - Control of Gaseous and Airborne Radioactivity (continued)
(to be completed if the answer to question 4 in Part 1 is "yes")

4.9 Is ventilation flow designed to maintain air pressure gradients and ventilation system balance to ensure that air flow across open doors, hood openings, hatches, and plug holes is sufficient and in the proper direction at all times?
4.10 Are air locks provided as necessary to assure proper boundary control?
4.11 Have penetrations, gratings, construction openings, etc., been evaluated for proper placement and sealing when open to areas of potential airborne activity?
4.12 Are differential pressures low enough not to impede the opening of doors or to keep doors from closing, or have provisions been made to compensate for high differential pressures (e.g., power assisted openers)?
4.13 Are auxiliary and local ventilation systems provided as necessary to control localized airborne contaminants?
4.14 Has hard piping to HVAC of relief valves and vents been avoided, where appropriate, except with proper additional provisions?
4.15 Have HEPAs, charcoal filters, electrostatic precipitators, molecular sieves, or other air cleaning devices been provided as appropriate?
4.16 Is intake air filtered to minimize dust accumulation in radiological areas and exhaust filter loading?
4.17 Are the connections provided for sampling probes in isokinetic locations, where required?
4.18 Are the direction changes in ductwork gradual and minimized?
4.19 Are filters located as close to the source as practicable, and before any fans, to reduce contamination buildup in the ductwork and fans?
4.20 Are welded seams employed in ductwork carrying contaminated air?
4.21 Have provisions been made to reduce localized airborne activity at its source by correct air flow, component selection, leakage collection, wetting down, decontamination, and the like?

SECTION 5 - Radioactivity Control
(to be completed if the answer to question 5 in Part 1 is "yes")

5.1 Where material might become activated, are corrosion-resistant materials and materials with low activation potential used as much as possible?
5.2 Is proper chemical and flow control used to minimize erosion and corrosion?
5.3 Have suitable lubricants, geometries, filters, and controlled leakage purges, as appropriate, been considered for minimizing the production and transport of particles to areas where they might become activated?
5.4 Are fluid system filters provided upstream rather than downstream of heat exchangers whenever possible?
5.5 Are components designed for ready draining, flushing, and cleaning by appropriate means?
5.6 Are radioactive systems designed to minimize or eliminate dead legs, standpipes, or low points with drains provided at any necessary dead legs, etc.?
5.7 If tank walkways are not set above the normal water level of the tank, are they designed to drain completely as the tank drains?
5.8 Have smooth surfaces been used wherever possible, to minimize erosion and the buildup of radioactivity?
5.9 Are butt welds or freeze fits used instead of socket welds for pipe connections, wherever possible?
5.10 Are consumable inserts rather than backing rings used in welds?
5.11 Are long runs of pipe, when unavoidable, sloped down and in the direction of flow to minimize radioactivity buildup?
5.12 Is the flow in pipes other than sample and radwaste lines laminar to prevent the deposition of radioactivity due to eddying?
5.13 Are eductors, spargers, etc., provided in tanks and other such vessels to ensure adequate mixing and minimize localized radioactivity buildup?
5.14 Are the numbers of flow restrictions, vents, drains, pipe fittings, flanges, bends, and tees minimized to reduce radioactivity deposition?
5.15 Have large radius pipe bends been used instead of elbows?
5.16 Is the usual flow for tees through the straight portion, with branch lines located above the run?
5.17 Are vertical and straight heat exchangers used instead of horizontal or U-tube types (i.e., best not to have the contaminated fluid on the tube side)?
5.18 Are tanks designed with conical or rounded bottoms, a central drain, and spargers to remove radioactive sediment from the tank?
5.19 Are connections and thermal expansion loops on pipes placed above the centerline?
5.20 Are orifices installed in vertical runs where possible?
5.21 Has the use of live loaded packing or bellows seals on valves been considered?
5.22 Are all valves installed in the stem-up position?
5.23 Have components been selected that minimize internal cavities, crevices, grooves, and pockets and can all components be completely drained?
5.24 Have any other potential radioactivity traps been identified and eliminated where possible?

Appendix 3F
(continued)
Checklist for ALARA Design Review
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SECTION 6 - Isolation and Decontamination
(to be completed if the answer to question 6 in Part 1 is "yes")

6.1 Have radioactive systems been separated from non-radioactive ones to reduce the potential for cross-contamination?
6.2 Are systems designed, where appropriate, with redundant components or trains, bypass features, and isolation points?
6.3 Has the need for decontamination been considered for each component, surface, area, or system?
6.4 Have contamination spread reduction features been provided (curbs, collection pans, trenches, etc.)?
6.5 Do floor penetrations have seals or raised sleeves to prevent water and dirt from falling to the floor below?
6.6 Where equipment decontamination is required, are stainless steel or coated pans or tanks provided to collect decontamination solutions?
6.7 Has hard piping to the floor drain system been avoided, or have appropriate additional provisions been made for relief valves and vents through which pressurized air, steam, or other gases may flow?
6.8 Are screens or filters provided on all venting paths when water or compressed gas is used to unplug lines?
6.9 Are surfaces which could become contaminated constructed without pockets, depressions, cracks, or sharp corners to prevent contamination buildup and facilitate drainage?
6.10 Are surfaces which might become contaminated constructed without pockets, depressions, cracks, or sharp corners to prevent contamination buildup and facilitate drainage?
6.11 Can radioactivity that has accumulated within a system or component be removed by recirculation, draining or flushing, or through chemical or physical action?
6.12 Are tanks designed with rounded or conical bottoms, a central drain, and spargers to facilitate decontamination?
6.13 Are alternate decontamination methods provided for components or areas where normal decontamination is not possible?
6.14 Are systems available to decontaminate tanks, sumps, pools, or like areas?
6.15 Are agitators or eductors provided to prevent settling, where appropriate?
6.16 Are the intake and discharge points for treatment or contamination systems located so as to eliminate stagnant areas?
6.17 Are pool treatment systems augmented by skimmer tanks to receive pool overflow?
6.18 Are local decontamination areas within low dose rate areas provided with space to accommodate equipment to be served and place close to drains and ventilation?
6.19 Are connections (such as hydrolasing access taps) and services (such as water, breathing air, etc.) placed near equipment wherever they may be needed?
6.20 Have appropriate decontamination methods and equipment which may be needed in the future been considered in planning services, connections, layout, sizing, ventilation, and location of decontamination facilities (including laundry facilities)?
6.21 Have berms, runoff ponds, etc., been provided for outdoor tanks containing radioactive materials?

SECTION 7 - Sampling and Radiation Monitoring
(to be completed if the answer to question 7 in Part 1 is "yes")

7.1 Are sampler, sample flow, and sampling line characteristics matched to the parameter(s) to be measured and to the physical characteristics of the source stream or volume to be measured?
7.2 Are sample probes placed in a location where sampling is isokinetic, if required, and upstream of filters (where applicable)?
7.3 Are sample probes in liquid streams located in a suitable flow region of the stream?
7.4 Are sampling systems designed for appropriate purge flow for quick, accurate samples?
7.5 Can sampling of high activity streams or volumes be done remotely?
7.6 Where appropriate, do hoods at sample stations or sinks operate automatically when samples are being taken?
7.7 Are samples (where applicable), overflows, and flush water or gas directed to drains or collectors and returned to the sampled system at some appropriate point or to the radwaste system?
7.8 Are air samples returned to an appropriate duct upstream of HVAC cleanup filter?
7.9 Are local sampling points minimized with as many samples as possible routed to local sampling station?
7.10 Are offline process, effluent, and airborne monitor and sampler lines made as short as possible and heat-traced as necessary to minimize sampler line loss, water condensation, and radioactivity buildup?

Appendix 3F
(continued)
Checklist for ALARA Design Review
Part 2

SECTION 7 - Sampling and Radiation Monitoring (continued)
(to be completed if the answer to question 7 in Part 1 is "yes")

7.11 Are monitor and sampler lines and chambers made of nonreactive materials, where appropriate, to avoid radioactivity buildup which might interfere with the proper functioning of the sensor?
7.12 Will a proposed modification of an area or system served by a radiation monitoring system have an insignificant effect on the performance characteristics, setpoints, or location of the constituent monitors or related process devices?
7.13 Will a proposed modification of a radiation monitoring system retain the performance characteristics, setpoints, or location of each of its constituent monitors or related process devices?
7.14 Are area radiation and airborne activity monitors provided for each area, and effluent and process monitors for each waste stream, as appropriate?
7.15 Are process and effluent monitors located to adequately monitor the conditions they are designed for and to provide enough lead time for isolation or diversion of their process streams, if necessary?
7.16 Are detectors located to provide optimal coverage of the area?
7.17 Have portal monitors, friskers, sorting monitors, etc., been located in low background areas or shielded, as necessary?
7.18 Do monitors have both local and remote readouts and alarms, where appropriate?
7.19 Can the readout of each monitoring system be recorded?
7.20 Does each instrument have ranges and sensitivity sufficient to ensure readout of the highest and lowest levels of activity, including accident conditions where applicable, and is the response time adequate for its function?
7.21 Is each monitor or monitoring system provided with a means to indicate component failure?
7.22 Are circuits and monitors built with fail-safe or backup capabilities?
7.23 Are monitors capable of being quickly and easily calibrated and tested, whether on the spot, remotely, or in some other location?
7.24 Are monitors qualified for the expected life doses at their locations?

SECTION 8 - Radwaste Collection and Processing System
(to be completed if the answer to question 8 in Part 1 is "yes")

8.1 Are runs of pipe made as short as possible?
8.2 Are lines carrying spent resins or slurries sloped downward wherever possible?
8.3 Is the line size at least 1.5" but small enough to maintain a velocity corresponding to turbulent flow, where appropriate?
8.4 Are flush lines sized to maintain fluid velocities?
8.5 Are pipe bends with a radius of five pipe diameters or greater used?
8.6 Are low points, dead legs, and flow restrictions avoided wherever possible?
8.7 Are all lines carrying spent resins or radioactive slurries designed without flow control valves, screwed connections, and orifices, and with as few other pipe connections and fittings as possible?
8.8 Is the usual flow for tees through the straight portion with branch lines located above the run?
8.9 Are full-ported plug or other appropriate valves used in resin and slurry systems and constructed so the concentrate will not interfere with the opening and closing of the valve?
8.10 Are butt welds used wherever possible instead of other types of welds or flanged connections, and are consumable inserts used instead of backing rings?
8.11 Can lines which may plug be backflushed or hydrolased?
8.12 Are pump seals on high concentrate pumps supplied with seal water during operation?
8.13 Are tanks designed with conical or dished bottoms, a central drain, and spargers or eductors?
8.14 Are tank overflow lines lower than vent lines and piped directly to an appropriate sump?
8.15 Are screens or filters provided in vent lines from tanks and can they be readily cleaned or backflushed?
8.16 Are there filters upstream and strainers downstream of demineralizers?
8.17 Are tanks, pipes, or other equipment processing radioactive concentrates supplied with heat tracing where appropriate?
8.18 Are valves sequenced so that flow does not slow drastically or stop between transfer and flushing?
8.19 Are radwaste shipping and storage areas designed for handling of all levels of waste which may be handled?
8.20 Can radwaste shipping containers be readily retrieved and loaded for shipment?
8.21 Has consideration been given to the processing of waste resulting from chemical decontamination measures?

Appendix 3F
(continued)
Checklist for ALARA Design Review
Part 2

SECTION 9 - Accessibility
(to be completed if the answer to question 9 in Part 1 is "yes")

9.1 Has accessibility been considered for all equipment and components requiring maintenance, inspection, removal, or replacement?
9.2 Are components placed so that structural members and pipes do not interfere with their function or access to them?
9.3 Is adequate pull, laydown, and working space provided?
9.4 Are doorways and labyrinths wide enough to permit necessary personnel, component, and equipment passage?
9.5 Are permanent platforms, scaffolds, walkways, stairs, or ladders provided to permit accessibility, or is the area roomy and low-dose enough for the ready erection of temporary access forms?
9.6 Are personnel access hatches and walkways sized to allow entry of suitably clothed and equipped workers?
9.7 Is appropriate space provided for access areas with friskers, bins, or drums for protective clothing, etc.?
9.8 Do cranes, monorails, forklifts, transfer carts, etc. have a clear path to the point of laydown?
9.9 Is equipment designed for ready removal with lifting lugs, pad eyes, overhead lifting points, and sufficient clearances?
9.10 Are units that are frequently pulled out of their installed position for checking mounted on racks, slides, or hinges?
9.11 Is a hinged door rather than a cover plate used where (human) physical access is required?
9.12 Is a cover plate with captive quick-opening fasteners used?
9.13 Is a window, quick opening metal cover, mirror, etc. used for visual access?
9.14 Are components arranged so that all throwaway parts are accessible without removing other components?
9.15 Has temporary or local shielding been considered in allotting access space?

SECTION 10 - Human Factors
(to be completed if the answer to question 10 in Part 1 is "yes")

10.1 Is proper lighting provided in the work area and is emergency lighting provided as backup?
10.2 Are functions, equipment, etc. clearly and permanently labeled or provided with secure explanatory tags and do these correspond to notations on system diagrams?
10.3 Are readouts clear, unambiguous, and located at eye level?
10.4 Have color coding and alignment marking of equipment, systems, or areas been considered?
10.5 Are hatches and walkways designed to allow suitably equipped and clothed workers visibility and maneuverability?
10.6 Has consideration been given to the provision of life lines to pull accidentally injured or unconscious workers from tanks, pools, or other areas of high dose rates or high airborne activity?
10.7 Are appropriate communications provided in the area?
10.8 Has sufficient speaker and siren coverage been provided so that all workers in radiological areas can be promptly alerted to hazards?
10.9 Are overhead clearances adequate?
10.10 Have noise levels been considered in the selection and usage of equipment, especially communications equipment?
10.11 Has consideration been given to "laydown space" for portable equipment and other items used in calibration, inspections, etc.?
10.12 Has consideration been given to human lifting capacity in selecting equipment, temporary shielding, etc.
10.13 Has the wearing of protective clothing, respirators, etc., been considered in selecting equipment for or designing areas in which temperatures may be high when workers enter?
10.14 Are special tools or equipment specific to one area provided and kept near that area?
10.15 Are operational sequences automated whenever possible?

SECTION 11 - Other Exposure Reduction Features
(to be completed if the answer to question 11 in Part 1 is "yes")

11.1 Are systems designed for ease of maintenance, consistent with ease of inspection and operations?
11.2 Have maintenance requirements of systems and equipment been considered in their selection and location?
11.3 Have the life expectancy and reliability of systems and equipment been considered in their selection and location?

Appendix 3F
(continued)
Checklist for ALARA Design Review
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SECTION 11 - Other Exposure Reduction Features (continued)
(to be completed if the answer to question 11 in Part 1 is "yes")

11.4 Have radiation resistant and environmentally resistant materials been selected for systems and equipment?
11.5 Have valves, in particular, been selected for low leakage, low maintenance, and low radioactivity accumulation properties?
11.6 Have similar components, which require service or replacement and which may be used throughout the facility, been standardized?
11.7 Is modular design used wherever possible (for temporary shielding, shield plugs, snap-on insulation, etc.)?
11.8 Are removal and installation of highly radioactive replaceable components, draining, flushing, sampling, remote survey, or radwaste drums, etc., done remotely?
11.9 Are seals flushed, pump casings and other equipment drained, and tanks and other equipment decontaminated, as appropriate, before maintenance?
11.10 Are canned pumps used in the system whenever possible and can all pumps be maintained without removing their motors?
11.11 Are quick electrical, mechanical, or hydraulic release mechanisms used for insulation, sample bombs, electrical connections - even entire skids, etc.?
11.12 Are flanges rather than welds used for quick removal when considering contamination buildup?
11.13 Have spare connections been provided on tanks located in high dose rate areas to allow flexibility of operation and maintenance?
11.14 Is equipment provided with lifting lugs to reduce rigging time?
11.15 Has consideration been given to using special tools to facilitate maintenance?
11.16 Have service connections been provided in high dose rate areas for ready use (e.g., air, water, electrical outlets) and are they appropriate for the equipment?
11.17 Are isolation valves, pump motors, controls, grease fittings, removable shielding, etc., accessible on the low dose rate area or side of the wall for maintenance?
11.18 Are screens provided on sump pump intakes to reduce the chance of failure due to extraneous matter?
11.19 Are standing pools of water drainable before and during maintenance?
11.20 Has provision been made to remotely move a frozen or entangled crane in a high dose rate area?
11.21 Have shielded containers been designed for easy receipt of filters, sample bombs, radwaste, etc.?
11.22 Is insulation marked to avoid unnecessary removal and for timely replacement?
11.23 As applicable, has consideration been given to the use of robots or robotic machines?
11.24 Are dead legs made as short as possible?
11.25 Are isolation valves located as close as possible to the penetration?
11.26 Are traffic patterns for maintenance, etc., established so that movement in and out of radiation areas is efficient with minimal crossing of paths?
11.27 Can equipment be moved to a lower dose rate area for maintenance if shielding is not practical?
11.28 Are activity containing components or structures inside security controlled areas equipped with barriers, alarms, etc., as necessary?

SECTION 12 - Optimization and Exposure of the Public and Environment
(to be completed if the answer to question 12 in Part 1 is "yes")

12.1 Will the total doses and concentrations for the facility or site remain below the limits specified or referred to in DOE Order 5400.5 is component, system, facility, or site airborne emissions are created or affected?
12.2 Will the total doses and concentrations for the facility or site remain below the limits specified or referred to in DOE Order 5400.5 if component, system, facility, or site drinking water pathway emissions are created or affected?
12.3 Has the need for additional monitoring or sampling points, or for different types and frequencies of samples been considered if component, system, facility, or site airborne or drinking water pathways emissions are created or affected?
12.4 Has a Best Available Technology (BAT) analysis been performed, where appropriate?
12.5 Has an optimization analysis been performed, where appropriate?
12.6 Has the possibility of "free release" of materials, equipment, etc., to the public or the environment, after or as a result of this design or modification, been considered?

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CHAPTER 4 RADIOACTIVE MATERIALS

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TABLES

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PART 1 Radioactive Material Identification, Storage, and Control

411 General

1. Materials in contamination, high contamination, or airborne radioactivity areas shall be considered contaminated until surveyed and released [see 835.1101(a)]. Any equipment or system component removed from a process that may have had contact with radioactive material should be considered contaminated until disassembled to the extent required to perform an adequate survey, surveyed, and shown to be free of contamination at levels exceeding the Table 2-2 values. These survey and release provisions do not apply to airborne radioactivity areas where only gaseous, short-lived (half-life of 1 hour or less) radionuclides are present. Detailed provisions for release of materials from radiological areas are provided in Article 421.

2. Radioactive material located within radiological areas does not require specific labeling or packaging if sufficient information is provided to allow individuals to take appropriate protective actions [see 835.606(a)]. The information may be provided by means of postings, pre-job briefings, training, or other appropriate means.

3. The site-specific radiological control standard should include response and notification requirements associated with a loss of radioactive material, including searches, internal investigations, documentation, and reporting. The radiological control organization should be notified in the event of a loss of radioactive material.

4. **At the WVDP:** Unsealed radioactive material shall be handled only by Radiological Worker II qualified personnel. The Radiation Safety organization shall institute and promulgate any rules and regulations necessary to assure strict compliance with the DOE regulations and orders for handling unsealed radioactive material. Radioactive material that is sealed (e.g., sealed source) or packaged in a container per Article 413 requirements may be handled by either qualified Radiological Worker I or II.

5. **At the WVDP:** On-site radioactive material is any item, substance, piece of equipment, etc., possessing levels of radioactivity above natural background exceeding any of the limits below and are subject to the requirements of 10 CFR 835 and DOE O 5400.5.

   A. **Soil** - any soil or soil-like material, including dry powder, excavated dirt, concrete and asphalt, shall be classified as radioactive material if the above background radionuclide concentrations exceed the following onsite radiological control limits:

   - 20 dpm/g alpha, or
   - 100 dpm/g beta-gamma.

   The soil levels presented above are for onsite classification purposes and radiological control at the WVDP facility. These levels shall not be used to release soil from the WVDP facility for environmental release and unrestricted use (see Article 422). Department of Transportation radioactive material classification limits or limits developed and approved in accordance with DOE O 5400.5 shall apply to offsite transport of radiologically contaminated soil.

   B. **Liquid** - any liquid or sludge shall be classified as radioactive material if concentrations exceed the following Derived Concentration Guidelines (DCGs) for gross alpha (i.e., DCG for Pu-239 and Am-241), gross beta (i.e., DCG for Sr-90), and tritium for environmental release purposes per DOE O 5400.5.

$$\frac{\mu Ci/ml\ alpha}{3.0 \times 10^{-8}} + \frac{\mu Ci/ml\ beta-gamma}{1.0 \times 10^{-6}} + \frac{\mu Ci/ml\ tritium}{2.0 \times 10^{-3}} \geq 1$$

The DCGs for ingested water listed in DOE O 5400.5 (Figure III-1) and Chapter 9, may be used in lieu of the above expression when individual radionuclides have been identified and quantified. In such cases, the liquid shall be classified as radioactive material if:

$$\sum_i \frac{\mu Ci/ml \text{ (radionuclide i)}}{DCG \text{ (radionuclide i)}} \geq 1$$

Radiological controls (e.g., personnel protection and control) are not required unless concentrations exceed 50 times the DCGs (listed below) for gross alpha, gross beta, and tritium, or, sum of the mixtures.

$$\frac{\mu Ci/ml \text{ alpha}}{1.5 \times 10^{-6}} + \frac{\mu Ci/ml \text{ beta} - \text{gamma}}{5.0 \times 10^{-5}} + \frac{\mu Ci/ml \text{ tritium}}{1.0 \times 10^{-1}} \geq 1, \text{ or}$$

$$\sum_i \frac{\mu Ci/ml \text{ (radionuclide i)}}{50 \times DCG \text{ (radionuclide i)}} \geq 1$$

C. **Radioactive Sources** - radioactive sources used for calibration and radiography, shall be classified as radioactive material if the source activity exceeds the limits listed in 10 CFR 835 Appendix E. The sum-of-fractions rule shall apply when the source contains more than one radionuclide. In addition to the general requirements imposed on radioactive material, control of radioactive sources shall be subject to the requirements in Article 431.

D. **Material and Equipment** - any item, such as vehicles, equipment, tools, clothing (except as provided in Article 461), etc., shall be classified as a radioactive material if it exceeds the unrestricted use limits for removable and total surface contamination in Table 2-2. Any material and equipment located or used in radiological areas where the possibility of surface contamination exists shall be treated as radioactive material. This radioactive material shall not be released, per Article 422, if contamination levels exceed the Table 2-2 criteria for surface contamination on any accessible surface, or if inaccessible surfaces cannot be rendered accessible by dismantling the item prior to survey.

E. **Radioactive Waste** - any radioactive material classified as radioactive waste per Part 4 of this chapter shall be subject to the specific requirements of that section.

F. **Naturally Occurring Radioactive Material (NORM)** - any NORM having a specific activity equal to or greater than 50 times it's DCG shall require radiological controls for handling purposes. Any NORM having a dose rate of 50 microrem/hour or greater on any accessible surface shall be stored in a Radioactive Material Area per Article 236.1A. NORM having a specific activity of less than 50 times it's DCG and having a dose rate less than 50 microrem/hour on all accessible surfaces are exempt from these requirements.

G. **Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)** - NORM that has been concentrated to levels above those found in the environment (e.g., TENORM) should be evaluated to determine the radiological controls that should be applied. If TENORM, or material containing TENORM, is determined to be a waste, then in the absence of Authorized Limits for release per DOE O 5400.5, it must be categorized and managed in accordance with the requirements for it's appropriate waste type (e.g., low-level waste, AEA Section 11e(2) byproduct material, etc.). Purposeful dilution to render TENORM exempt shall not be allowed.

6. **At the WVDP:** Hazardous/toxic and industrial wastes intended for off-site disposition (i.e., disposal, recycling, etc.) shall be certified as to its radiological pedigree prior to release from the WVDP, in accordance with established standard operating procedures for classifying waste per Federal and State hazardous waste regulations and DOE Headquarters Performance Objective and Certification of Non-radioactive Hazardous Waste.

412 Radioactive Material Labeling

1. 10 CFR 835 requires labeling of individual containers of radioactive material and radioactive items except under certain specified conditions in which existing postings and control measures provide adequate warning [see 835.605 and 835.606(a)].

2. Postings and access control requirements for radiological areas generally provide sufficient personnel protection to negate the need for individual container or item labeling; however, items having removable contamination in excess of the Table 2-2 values should be labeled when used, handled, or stored in areas other than contamination, high contamination, or airborne radioactivity areas.

3. Required labels shall include the standard radiological warning trefoil and the words “Caution” or “Danger” and “Radioactive Material” [see 835.605]. The “Danger” heading should be used when an individual exposed to, using or handling the material could receive an equivalent dose exceeding any applicable administrative control level in one hour. The radiation warning trefoil shall be black or magenta and imposed upon a yellow background [see 835.601(a)]. Magenta is the preferred color for the trefoil and the lettering.

4. Required labels shall also provide sufficient information to permit individuals handling, using, or working in the vicinity of the labeled material to take appropriate actions to control exposures [see 835.605]. The following information should be included on radioactive material labels, to the extent appropriate to the radiological hazard created by the material and the education, training, and skills of the individuals who may be exposed to the hazards:

   A. Radionuclide(s)

   B. Radiological hazard information (e.g., radiation and contamination levels)

   C. Total quantity of radioactive material (in subunits or multiple units of curies)

   D. Date of survey

5. If an item is too small to be labeled with all of the desired information, the label should be applied to the device or storage location with sufficient information available to trace the item to the appropriate label.

6. If a label is applied to packaged radioactive material, the label should be applied to the outside of the package or be visible through the package.

   A. **At the WVDP:** External labeling or tagging is required for:

      1. Items that are wrapped or packaged to contain removable surface contamination;

      2. Containers of radioactive material;

      3. Moveable items with surface contamination levels greater than those listed in Table 2-2.

7. Radioactive materials and containers should be labeled in accordance with Table 4-1.

8. **At the WVDP:** In addition to those items listed in Table 4-2, the following items are also excepted from labeling:

   A. Items which are located in an enclosure limiting their removal. However, the enclosure shall be labeled to indicate radioactive materials are contained within.

   B. Commercially available quantities of radioactive material in exempt quantities that are not subject to the requirements of 10 CFR 835; such as smoke detectors, glass or ceramic dishes, thorium welding electrodes, etc. See Articles 114.8 and 114.9 for naturally occurring radioactive material and radioactive material in consumer products that are exempt from requirements contained in this manual.

Table 4-1 Radioactive Material Labeling

ITEM/MATERIAL	REQUIREDLABELING[1]	SUPPLEMENTAL LABELING
Equipment, components, and other items that are radioactive, potentially radioactive, or have been exposed to radioactive contamination or activation sources	Standard radiation warning trefoil, and "CAUTION" or "DANGER" and "RADIOACTIVE MATERIAL" [see 10 CFR 835.605]	"CONTAMINATED" or "POTENTIALLY CONTAMINATED"
Sealed and unsealed radioactive sources or associated storage containers		
Equipment, components, and other items with actual or potential internal contamination		"INTERNAL CONTAMINATION" or " POTENTIAL INTERNAL CONTAMINATION"
Components, equipment, or other items with fixed contamination		"FIXED CONTAMINATION"

[1] Labeling required on item or container meets the criteria established in 10 CFR 835.605.

Table 4-2 Exceptions from Radioactive Material Labeling Requirements

Exception Criteria	Items Typically Included*
Material is used, handled, or stored in radiological areas or radioactive material areas [see 835.606(a)(1)]	All radioactive material in radiological areas and radioactive material areas. This exception should not be applied to items that have removable contamination exceeding the Table 2-2 values that is stored outside of contamination, high contamination, or airborne radioactivity areas.
Material having a total quantity of radioactive material below one tenth of the values in Appendix E of 10 CFR 835and less than 0.1 Ci. [See 835.606(a)(2)]	Items having extremely low levels of radioactive material content, such as low-activity sealed radioactive sources, laundered personal protective equipment and tools and equipment having low levels of fixed contamination
Material that has been packaged, labeled, and marked in accordance with the applicable (e.g., DOE or Department of Transportation) radioactive material transportation requirements [see 835.606(a)(3)]	Radioactive material packages awaiting shipment
Material that is inaccessible, or accessible only to individuals authorized to handle or use them, or to work in the vicinity [see 835.606(a)(4)]	Material stored in locked areas or areas having strict physical and administrative entry controls that preclude unauthorized entry. Radioactive samples being handled or transported by authorized personnel.
Material that is installed in manufacturing, process, or other equipment [see 835.606(a)(5)]	Piping, tanks, valves, instrument sensors, test sources, etc., that are installed in immobile systems
Material that consists solely of nuclear weapons or their components [see 835.606(a)(6)]	Nuclear weapons components

* Caution must be exercised to ensure that the listed items actually meet the criteria established in the first column.

Note - Caution should also be exercised to ensure that other applicable requirements (e.g., member of the public dose limits [Table 2-1], training requirements [Table 3-1], ALARA requirements [Article 117], controlled area dose expectation [Article 232]) will be met in the absence of radioactive material labels.

413 Radioactive Material Packaging

1. Radioactive material that is outside contamination, high contamination, or airborne radioactivity areas and is confirmed or suspected of having removable radioactive contamination levels greater than Table 2-2 values should be securely wrapped in plastic or placed in a closed container.

2. Radioactive material with sharp edges or projections should be taped or additionally protected to ensure package integrity.

3. Radioactive material with removable or potentially removable contamination levels in excess of 100 times Table 2-2 values should have additional packaging controls such as double-wrapping or the use of plastic bags inside containers.

4. Yellow plastic wrapping material (or clear plastic bags properly marked) should be used for packaging radioactive material and should not be used for non-radiological purposes.

   A. **At the WVDP:** Clear plastic bags with the radiation symbol may be used for packaging or wrapping materials [*Article 113*].

5. The amount of combustible material used in packaging should be minimized.

6. **At the WVDP:** Containment is not mandatory within Contamination or High Contamination Areas; however, items with removable surface contamination should be wrapped, bagged, or otherwise controlled while in these areas to minimize the spread of contamination.

414 Radioactive Material Storage

1. Radioactive material in quantities exceeding the applicable quantities shall be used, handled, and stored in a radioactive material area or other area posted in accordance with Article 234 or 235, as appropriate [see 835.2(a), radioactive material area, and 835.603].

2. Decontamination or disposal of radioactive material is the preferred alternative to long-term storage.

3. Each radioactive material storage area should be established consistent with guidelines in the site-specific radiological control standard. The radiological control manager or designee has the authority to preclude the establishment of a radioactive material storage area.

4. A custodian should be assigned responsibility for each radioactive material storage area. A custodian may have responsibility for more than one storage area.

5. The custodian should conduct walk-throughs of radioactive material areas at least monthly to check integrity of containers and wrapping materials.

6. The custodian should conduct annual or more frequent reviews of each radioactive material area, with emphasis on treatment, decontamination, movement of material to long-term storage locations, and disposal of unneeded material.

7. Storage of non-radioactive material in a radioactive material storage area is discouraged.

8. Outdoor storage of radioactive material is discouraged. In cases where outdoor storage is necessary, the integrity of containers or wrapping materials used should be ensured to prevent degradation from weathering and subsequent release of radioactive material.

   A. **At the WVDP:** Outdoor Radioactive Material Area designs and proposals should include the following considerations:

      1. Areas should be curbed in such a manner as to direct any pad runoff to an acceptable localized collection area.

      2. The surface of the storage pad should be coated with a sealant to prevent absorption of contamination.

      3. Devices such as skids or shelves should be used to store packaged items several inches above the pad surface.

   B. **At the WVDP:** Areas shall be surveyed by Radiation Safety organization at least monthly to detect possible contamination leakage from packages.

   C. **At the WVDP:** Radiation Safety organization shall be notified prior to moving an item from the storage area.

   D. **At the WVDP:** Items shall be placed in such a way that they do not increase radiation levels in occupiable portions of the facility.

9. Radioactive material should be stored in a manner that reduces combustible loading. The use of cardboard containers for storage is discouraged.

10. Flammable or combustible materials should not be stored adjacent to radioactive material storage areas.

11. Fire protection measures, such as smoke detectors, water sprinklers, and fire extinguishers, should be considered when establishing a radioactive material storage area.

12. **At the WVDP:** All moveable unattended radioactive materials or equipment shall be located within a posted Contamination Area, High Contamination Area, or Radioactive Material Area.

13. **At the WVDP:** The highest exposure rate measured at 30 cm from any surface of the object shall determine the minimum Radiation Area control requirements. For example, an item with an exposure rate of 200 mrem/hr at 30 cm from its surface shall be located in a High Radiation Area, but shall not be located in a Radiation Area.

14. **At the WVDP:** No items with removable contamination levels exceeding the limits in Table 2-2 shall be stored in a Radioactive Material Area. This limit shall apply to the outermost surface of the container. Items that are classified as radioactive material by virtue of their removable contamination levels shall not be located in a posted Radioactive Material Area unless they are properly contained and labeled.

15. **At the WVDP:** Radioactive material that is not contained in an appropriate waste container and is not located in a radiological area shall be continuously attended by a properly qualified radiological worker. The radioactive material shall be placed in an appropriate radiological area as soon as practical.

16. **At the WVDP:** With the approval of the Radiation Safety Manager, all soil that contains radioactivity of 100 dpm/gram (beta-gamma) or 20 dpm/gram (alpha) greater than background radioactivity levels may be stored uncontainerized on-site provided activity levels are less than or equal to the Derived Containerization Criteria cited in WVDP-304. Any soil that exceeds the Derived Containerization Criteria cited in WVDP-304 shall be containerized. For work activities / excavations where soil contamination, including any soil greater than the Derived Containerization Criteria, is encountered, the decision whether to clean-up or leave as-is (and cover or contain) will be made on a case-by-case basis with Radiation Safety, the Facility Manager, and the cognizant work activity manager.

PART 2 Release and Transportation of Radioactive Material From Radiological Areas

421 Release to Controlled Areas

Once materials and equipment have entered radiological areas controlled for surface contamination or airborne radioactivity, comprehensive and time-consuming evaluations of the potential for contamination are required prior to releasing the material or equipment to controlled areas. Likewise, exposure of certain materials and equipment to a beam of neutrons or other particles produced in a nuclear reactor or particle accelerator may result in activation of that material or equipment, resulting in the creation of radioactive material requiring controlled use, storage, and disposal. The need for evaluation of the radiological characteristics of these materials and equipment and implementation of appropriate controls provides substantial impetus for implementation of measures to limit the amount of material and equipment that enters radiological areas and to prevent contamination or activation of materials and equipment that do enter these areas.

1. Accessible surfaces of material or equipment that has entered contamination, high contamination, or airborne radioactivity areas shall be surveyed prior to release from these areas to controlled areas [see 835.1101(a)]. Guidance for conducting these surveys is provided in the footnotes to Table 2-2.

2. If an assessment of the prior use of the material or equipment indicates that inaccessible surfaces are not likely to be contaminated in excess of applicable limits, a complete survey of accessible surfaces and documentation of the assessment may be an appropriate basis to release materials to the controlled area [see 835.1101(a)(2)].

3. If an assessment of the prior use of the material or equipment indicates that inaccessible surfaces are likely to be contaminated to levels in excess of the Table 2-2 values, then the material shall not be released from the radiological area, except as permitted under Article 421.5 or 421.6 [see 835.1101(a)(2)]. If it is necessary to release the material or equipment from the radiological area, the material or equipment should be disassembled to the extent necessary to perform adequate surveys.

4. Removable contamination levels shall be less than Table 2-2 values prior to releasing material and equipment for unrestricted use in controlled areas [see 835.1101(a)(1) & (a)(2)].

5. Material and equipment with fixed contamination levels that exceed the total contamination values specified in Table 2-2, and removable contamination levels less than Table 2-2 values, may be released for restricted use in controlled areas outside of radiological areas [see 835.1101(c) & (c)(1)]. The material or equipment shall be routinely monitored and clearly marked or labeled to alert individuals to the contaminated status [see 835.1101(c)(2)]. Written procedures should be developed to establish requirements for monitoring of the material or equipment and surrounding areas, control of access to these areas, authorized uses of the material or equipment, and contingency plans for spread of radioactive contamination.

6. Material and equipment with total or removable contamination levels exceeding Table 2-2 values may be moved on site from one radiological area to another if appropriate monitoring is performed and appropriate controls are established and implemented [see 835.1101(b)]. These controls should include provisions for containment to the extent practicable, labeling in accordance with Article 412, monitoring and control of the transfer route and participating individuals, and control of spills.

7. The requirements of 10 CFR 835.1101 apply only to material and equipment that is radioactive due to the deposition of radioactive surface contamination. Although DOE has not established any specific controls over the release of other radioactive materials (e.g., activated materials or materials that are naturally-radioactive) to controlled areas, the release of these materials is subject to other requirements of 10 CFR 835. The following regulatory requirements and guidance are applicable to the release of this type of material and equipment.

A. Controls shall be adequate to ensure compliance with the radiation safety training requirements of 10 CFR 835.901 [see 10 CFR 835.901]. Release of material and equipment to controlled areas may result in occupational or non-occupational exposure of individuals to radiation. Chapter 6 provides guidance for implementing an appropriate training program;

B. Controls shall be adequate to ensure compliance with the 100 millirem in a year controlled area maximum total effective dose expectation [see 10 CFR 835.602]. DOE sites should adopt site- or facility-specific criteria that will ensure that intrinsically-radioactive material and equipment that is released to the controlled area, in combination with other sources of radiation in the controlled area, will not result in any individual exceeding this dose expectation.

C. Controls shall be adequate to ensure the ALARA process is properly implemented [see 10 CFR 835.101 and 1001 - 1003]. Given the low levels of radioactivity that are likely to be present in material and equipment being considered for release to controlled areas, the controls should not be burdensome. Options that should be considered include retention in radiological areas, placement in specified areas with appropriate access restrictions and usage controls, posting, labeling or color-coding, storage for decay, removal of radioactive components, and disposal as radioactive waste.

8. When radioactive materials are moved outside of radiological areas, controls should be established to ensure no unmonitored individual is likely to exceed an equivalent dose that would require monitoring in accordance with Article 511 or 521.

9. Records for release of materials should describe the property, date of last survey, identity of the individual who performed the survey, type and identification number of the survey instruments used, and survey results. For small items and packages of similar items (such as boxes of tools or boxes of fasteners), it is not necessary to create a separate survey record for each item. However, the survey record should provide traceability to the individual removing the item from the radiological area.

10. 10 CFR 835 requirements do not apply to radioactive material on or within material, equipment, and real property which is approved for release when the radiological conditions of the material, equipment, and real property have been documented to comply with the criteria for release set forth in a DOE authorized limit and which has been approved by a Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.

422 Release to Uncontrolled Areas

1. DOE O 5400.5 and associated guidance documents describe the process for release of surface contaminated material, equipment or real property based on authorized limits.

A. Material, equipment or real property for which the authorized limit meets the generic guidelines in DOE O 5400.5 may be released without any restrictions on future use.

B. In addition, authorized limits may be approved for material, equipment or real property with surface contamination levels greater than the generic guidelines.

C. **At the WVDP:** When referring to DOE O 5400.5, Figure IV-1, use the following values for allowable total residual surface contamination (dpm/100 cm^2) for transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, and Pa-231:

Average	Maximum	Removable
100	300	20

2. DOE O 5400.5 criteria for unrestricted release of surface contaminated material, equipment or real property may be more stringent than those established in this standard for release of surface contaminated material, equipment and real property.

3. DOE O 5400.5 and associated guidance documents describe the process for obtaining approved authorized limit for releasing material, equipment or real property that has been contaminated in depth or volume, such as activated materials or smelted material.

4. Material, equipment or real property with radioactive material on its surface or within its volume is exempt from the provisions of 10 CFR 835 if it may be released in accordance with an authorized limit approved by a Secretarial Officer in consultation with the Chief Health, Safety and Security Officer [10 CFR 835.1(b)(6)].

5. **At the WVDP:** For the release of materials and equipment, the following requirements shall be applied:

   A. Prior to materials and equipment being released, property shall be surveyed to determine whether both removable and total surface contamination (including contamination present on and under any coating) is greater than the levels given in Table 2-2 and that the contamination has been subjected to the ALARA process.

   B. Property shall be considered to be potentially contaminated if it has been used or stored in radiological areas that could contain unconfined radioactive material or that are exposed to beams of particles capable of causing activation (neutrons, protons, etc.).

   C. Surfaces of potentially contaminated property shall be surveyed using instruments and techniques appropriate for detecting the limits stated in Table 2-2.

   D. Where potentially contaminated surfaces are not accessible for measurement (as in some pipes, drains, and ductwork), such property may be released after case-by-case evaluation and documentation based on both the history of its use and available measurements demonstrate that the nonsurveyable surfaces are likely to be within the limits given in Table 2-2.

   E. The records of released property shall include:

      1. A description or identification of the property;

      2. The date of the last radiation survey;

      3. The identity of the individual who performed the monitoring operation;

      4. The type and identification number of monitoring instruments;

      5. The results of the monitoring operation; and

      6. The identity of the recipient of the released material.

   F. No guidance is currently available for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass).

6. **At the WVDP:** The radiological release criteria and procedures for demonstrating compliance with DOE O 5400.5 includes the use of process knowledge, as well as surface contamination surveys, sampling and analysis, or by a combination of these techniques. Process knowledge is defined as the understanding of the process generating/using a(n) waste/material/item and the subsequent management of the waste/material/item, which may be used alone or in conjunction with another method in determining whether a(n) waste / material / item is radiologically contaminated. The process knowledge decision, and the rationale for the decision, that a(n) waste/material/item is not potentially radiologically contaminated must be documented, approved, and in a readily retrievable form traceable to the waste / material / item. The Radiation Safety approval shall be made by individuals qualified by training and/or cognizant of the origin, use, and potential for exposure of the waste/material/item in question. Each approval shall be traceable to the documented rationale for the decision that no radiological contamination is present.

423 Transportation of Radioactive Material

1. 49 CFR 170 through 180 establish requirements for inspecting and surveying packages, containers, and transport conveyances prior to transport via the public transportation system. These regulations apply to radioactive material transportation in commerce.

2. DOE Orders 460.1B, Packaging and Transportation Safety and 460.2A, Departmental Materials Transportation and Packaging Management provide requirements that are in conformance with 49 CFR requirements for transportation of radioactive material using any conveyance. 10 CFR 835.1(b)(7) excludes activities not performed by DOE or DOE contractors. 10 CFR 835.1(b)(7) excludes radioactive material transportation not performed by DOE or DOE contractors from compliance with 10 CFR 835 regulations. However, radioactive material transportation (as defined in 10 CFR 835) does not include preparation of materials for shipment, packaging and labeling, or storage of material awaiting transportation for shipment. These activities shall be conducted in accordance with 10 CFR 835 [see 835.2(a), radioactive material transportation, and 835.1(b)] and should be conducted in accordance with this Standard.

3. Table 2-2 removable contamination values are more limiting than 49 CFR requirements and should be used as controlling limits for on-site and off-site transportation when using a conveyance that is owned by DOE or a DOE contractor [835.1(d)]. However, when a shipment is received from an off-site destination, by a non-DOE conveyance, the 49 CFR 173 transportation contamination values should be applied to all subsequent on-site transfers to the ultimate on-site destination.

4. On-site transfers over non-public thoroughfares or between facilities on the same site should be performed in accordance with written procedures utilizing pre-approved routes. The procedures or other measures should include requirements to ensure appropriate monitoring and control of the radioactive material and should be approved or concurred with by the radiological control organization.

5. On-site transfers over public thoroughfares by non-DOE conveyance shall be performed in accordance with Department of Transportation, state and local shipping requirements and pre-approved agreements. Onsite transfers over public thoroughfares by DOE conveyance shall be performed in accordance with applicable DOE Orders and should conform with state and local shipping requirements and pre-approved agreements [see DOE 460.1B].

6. Before shipment and upon receipt of a radioactive material shipment, a visual inspection of packages should be performed to ensure that packages are not damaged. The inspection should identify dents, flaking paint, debris, package orientation, and any indication of leakage.

7. Before shipment and upon receipt of a radioactive material shipment, a comparison of package count to the shipping manifest should be made to ensure accountability.

8. Transport conveyances should be visually inspected prior to loading to ensure the trailers are acceptable for the intended use.

9. To the extent practicable, transport conveyances should be radiologically surveyed before loading, especially when using commercial carriers specializing in radioactive transport. The surveys should be adequate to identify any contamination remaining on the vehicle from previous radioactive material transport evolutions, such that DOE and its contractors would not be held liable.

10. Transport of large volumes of radioactive material by non-DOE motor vehicles should be "exclusive use" to prevent commingling of DOE and other commercial shipments.

11. The site emergency plan should describe provisions for response for those potential on-site radioactive material transportation accidents that would be categorized as an Operational Emergency

12. Specific arrangements shall be made for receiving packages containing radioactive material, regardless of the means of conveyance, in excess of Type A quantities (as defined in 10 CFR 71.4). These arrangements shall include making arrangements to receive packages upon delivery or to receive notification of delivery which leads to expeditious receipt of the package [see 835.405(a)].

13. Written procedures for safely opening packages should be developed and maintained. These procedures should include due consideration of the type of package and potential hazards present.

14. **At the WVDP:** All departments shall notify the Radiation Safety organization immediately upon receipt of any item marked, labeled, or suspected of being radioactive material. If a shipment of radioactive material arrives at the WVDP main gate, the Radiation Safety organization shall immediately conduct the appropriate surveys prior to the vehicle or shipment being permitted on-site.

15. **At the WVDP:** Immediately upon radioactive material being delivered to the warehouse, warehouse personnel shall contact the Radiation Safety organization requesting immediate response to properly survey the item, isolate the area, making sure that no one handles or approaches the material until Radiation Safety organization personnel arrive.

PART 3 Sealed Radioactive Source Controls

431 Sealed Radioactive Source Controls

Sealed radioactive sources as defined in 10 CFR 835.2 having activities equal to or exceeding the values specified in 10 CFR 835 Appendix E are considered accountable sealed radioactive sources.

1. Written procedures shall be established and implemented to control accountable sealed radioactive sources. These procedures should establish requirements for source acquisition, receipt, storage, transfer, inventory, leak testing, and usage.

2. Accountable sealed sources and all other sealed radioactive sources having activities exceeding one tenth of the values in Appendix E, 10 CFR 835, or their storage containers, shall be labeled with the radiation symbol and "CAUTION" or "DANGER" and "RADIOACTIVE MATERIAL" [see 835.605]. The label shall also provide sufficient information to control exposures [see 835.605]. Because of the wide variety of labels that are affixed to sealed radioactive sources by their manufacturers, these labels are excepted from the normal color scheme of magenta or black on yellow [see 835.606(b)]. If the size or configuration of the source precludes application of a suitable label, the label should be attached to the source container or mechanism.

3. Each accountable sealed radioactive source shall be inventoried at intervals not to exceed six months [see 835.1202(a)]. This inventory shall [see 835.1202(a)]:

   A. Establish the physical location of each accountable sealed radioactive source.

   B. Verify that the associated posting and labeling are adequate

   C. Establish that storage locations, containers, and devices are adequate

4. Each accountable sealed radioactive source shall be subject to a source leak test upon receipt, when damage is suspected and at intervals not to exceed six months [see 835.1202(b)]. Source leak tests shall be capable of detecting radioactive material leakage equal to or exceeding 0.005 µCi (as indicated by the presence of 0.005 µCi or more activity on the leak test sample) [see 835.1202(b)].

5. Periodic leak tests need not be performed if the source has been documented to have been removed from service. Such sources shall be stored in a controlled location and subject to periodic inventory in accordance with Article 431.3 and subject to leak testing prior to being returned to service [see 835.1202(c)].

6. If a source is located in an area that is unsafe for human entry or otherwise inaccessible, (such as due to operational or environmental constraints), then periodic inventories and leak tests need not be performed [see 835.1202(d)]. When the conditions that restrict access to the area have been terminated, the inventory and integrity test should be performed before allowing uncontrolled access to the area.

7. If an accountable sealed radioactive source is found to be leaking radioactive material, then controls shall be established to prevent the escape of radioactive material to the workplace [see 835.1202(e)]. These controls should include wrapping or containing the source, applying appropriate labels, and removing the source from service.

8. Both accountable and non-accountable sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources [see 835.1201].

9. The site-specific radiological control standard should specify controls for sealed radioactive sources having activities below one tenth of the accountability values in Appendix E, 10 CFR 835 to ensure their retention and proper use and storage.

10. Procurement of radioactive sources should be coordinated with the radiological control organization.

11. Receipt surveys of radioactive material shipments should be performed by the radiological control organization in accordance with Articles 552 and 554.

12. Sealed radioactive sources, including radiography sources, should not be brought on-site by external organizations without the prior knowledge and approval of the radiological control organization.

13. A custodian should be appointed to coordinate sealed radioactive source procurement, issue, inventory, leak testing, and other aspects of the sealed radioactive source control program. If justified by the scale of the program, sealed radioactive source user groups should appoint group-specific custodians to coordinate activities involving sealed radioactive sources within the group.

14. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C," Radiation Protection Programs Guide."

15. **At the WVDP:** The time interval to conduct sealed radioactive source activities under 10 CFR 835.1202(a) and 1202(b) may be extended by a period not to exceed 30 days to accommodate scheduling needs [**10 CFR 835.3(e)**].

PART 4 Solid Radioactive Waste Management

441 Requirements

1. DOE O 435.1, Radioactive Waste Management,, describes how solid radioactive waste is treated, packaged, stored, transported, and disposed.

   A. **At the WVDP:** All radioactive waste containers and packages shall be stored in areas approved by the Radiation Safety organization.

2. Radiological operations generating radioactive waste should be designed and developed to promote minimization and permit segregation, monitoring, treatment, storage, and disposal [DOE O 435.1].

3. Radioactive waste minimization goals and practices should be developed and implemented [DOE O 435.1].

4. **At the WVDP:** Radioactive solid waste is classified as either contact handleable or noncontact handleable based upon the exposure rate on contact with the waste containers.

   A. Contact handleable radioactive wastes are defined as wastes having a contact exposure rate of <200 mR/hr. These radioactive wastes do not require shielding during collection or storage, but shall also be collected and packaged so as to minimize exposure and contamination. Where possible, non-radioactive waste shall be segregated from radioactive waste during collection.

   B. Non-contact handleable waste is defined as waste having a contact exposure rate of ≥200 mR/hr. Non-contact handleable radioactive waste should be processed to decrease contact exposure rate levels to less than 200 mR/hr by overpacking and/or by using shielded containers prior to removal to storage. These procedures shall ensure that non-contact handleable wastes are collected and packaged in a manner that minimizes occupational exposure, airborne radioactivity, and surface contamination levels to as low as reasonably achievable and practicable levels.

5. **At the WVDP:** For onsite activities, radioactively contaminated soil is defined as soil that exceeds the concentrations presented in Article 411. All radioactively contaminated soil shall be stored in accordance with Article 414. Soil which does not exceed the concentrations presented in Article 411 may be released on-site to Controlled Areas at the discretion of the Radiation Safety organization. No soil shall be released off-site without authorization from the Radiation Safety organization.

6. **At the WVDP:** Material that is not contaminated with radioactivity, but that is commonly associated with radiation, such as placards, package logos, radiation boundary ribbons, and containers, shall be controlled in such a way (such as defacing or shredding) as to ensure that it cannot be incorrectly interpreted as being contaminated after disposal.

7. **At the WVDP**: For purposes of disposal, Naturally Occurring Radioactive Material (NORM) containing uranium or thorium and their progeny shall be treated as low-level radioactive waste. NORM containing potassium, but no radioactivity resulting from DOE activities, should be treated as industrial waste.

442 Waste Minimization

A radioactive waste minimization program should be in effect to reduce the generation of radioactive waste and spread of contamination from contamination, high contamination, or airborne radioactivity areas [see DOE O 435.1]. The following practices should be evaluated and instituted as appropriate to support waste minimization:

1. Restrict material entering radiological buffer areas and other areas surrounding contamination, high contamination and airborne radioactivity areas to that needed for performance of work.

2. Restrict quantities of hazardous materials, such as paints, solvents, chemicals, cleaners, and fuels, entering radiological buffer areas and other areas surrounding contamination, high contamination and airborne radioactivity areas and implement measures to prevent inadvertent radioactive contamination of these materials.

3. Substitute recyclable or burnable items in place of disposable ones and reuse equipment, chemicals, solvents, and cleaners when practical.

4. Select consumable materials such as protective coverings and clothing that are compatible with waste-processing systems, volume reduction, and waste form acceptance criteria.

5. Reserve an assortment of tools primarily for use in contamination, high contamination, or airborne radioactivity areas. Tools should be maintained in a designated storage or distribution area or a contaminated tool crib. Controls should be established for tool issuance and use.

6. Survey potentially contaminated material from contamination, high contamination and airborne radioactivity areas to separate uncontaminated from contaminated materials.

7. Segregate known uncontaminated from potentially contaminated waste.

8. Segregate reusable items, such as protective clothing, respirators, and tools, at the step-off pad.

9. Minimize the number and size of radioactive material areas.

10. Emphasize training in waste reduction philosophies, techniques, and improved methods.

443 Mixed Waste

Requirements specified in the Resource Conservation and Recovery Act and Toxic Substances Control Act apply to waste that contains both radioactive and hazardous materials.

1. Technical and administrative controls should be established to minimize the volume of mixed waste generated and the amount of radioactivity in such waste. Volume reduction methods include process optimization, materials substitution, and new technology development.

2. Materials suspected of being mixed waste should be identified and segregated as soon as practical in the generating process to avoid combining mixed waste with other waste forms.

PART 5 Control of Radioactive Liquids and Airborne Radioactivity

451 Minimization and Control of Radioactive Liquid Wastes

DOE O 435.1 provides criteria for minimizing the generation of radioactive liquid waste.

452 Control of Radioactive Drains

Radioactive drain systems are designed to transport radioactive liquids. Improper use may cause an environmental release.

1. Radioactive drain systems should not discharge to the environment nor be used for the disposal of non-radioactive liquids.

2. Existing radioactive drains should be evaluated to ensure the following:

   A. Verification of the existing radioactive drain piping configuration

   B. Installation of flow-indicating devices in leak-off lines

   C. Use of plugs to prevent non-radioactive input

   D. Consideration of alternative work controls before systems are drained for maintenance

   E. Controls prohibiting unauthorized use of drains.

3. Modifications to the design or operation of existing radioactive drain systems should be controlled to include:

   A. Design considerations that prevent non-radioactive drain connections into radioactive drains

   B. Procedural and design controls to prevent cross-connections of radioactive drains with non-radioactive systems

   C. Management review of subsequent changes to the design of radioactive drain systems or radioactive drain controls

   D. Management controls to restrict the introduction of hazardous wastes into radioactive drain systems.

453 Control of Airborne Radioactivity

1. The radiological control organization should be notified when engineering controls that prevent worker exposure to airborne radioactivity, such as barriers, gloveboxes, and glovebags, are compromised. An evaluation should be made of continuing operations with compromised engineering controls. The use of respiratory protection to continue activities under these conditions is discouraged. Implementation of short-term engineering modifications that provide a commensurate level of worker protection is the preferred alternative.

2. Preventive maintenance and surveillance procedures should be established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

3. **At the WVDP:** Processes and activities with the potential for producing airborne radioactivity shall include engineering controls to limit releases whenever appropriate. The requirements of 40 CFR 61 shall be included in the evaluation.

   A. Radioactivity in airborne effluent released shall be monitored to ensure compliance with release limits specified in DOE O 5400.5, to evaluate the effectiveness of controls, and to provide information on the type and quantity of radioactivity released by operations. This environmental monitoring program is the responsibility of the Regulatory Affairs Department.

4. **At the WVDP:** Airborne radioactivity is the presence of radioactive gas, vapor or particulate material in the air. Control of airborne radioactivity is necessary to limit the internal radiation exposure that can result from the inhalation, ingestion, or percutaneous absorption of radioactive material.

   A. If the calculated average DAC exceeds 1.0 (unity), the area shall be posted as an Airborne Radioactivity Area per Article 235. The RWP shall specify the applicable respiratory protection requirements for entry into an Airborne Radioactivity Area.

   B. To determine if posting for airborne radioactivity in a room or area is required, the volume and counting time of the sample should be sufficient and capable of detecting one DAC when averaged over 8 hours or 8 DAC-hours.

5. **At the WVDP:** As a design objective, exposure of personnel from inhalation of airborne radioactive materials shall be avoided using engineering controls under normal operating conditions to the extent reasonably achievable. This should normally be accomplished by confinement and/or ventilation.

   A. **At the WVDP:** When establishing radiological controls for work involving potential airborne radioactivity, the first consideration should be to use procedures and techniques (i.e., decontamination and/or use of fixatives) that will prevent airborne radioactivity. Loose surface contamination in radiological areas should be maintained to levels as low as is reasonably achievable.

   B. **At the WVDP:** All air handling systems specifically designed to control radioactive materials that discharge to the environment shall include HEPA filters that should be efficiency tested when first put into service and retested annually. All efficiency tests shall be performed in accordance with ANSI N510, "Testing of Nuclear Air-Cleaning Systems." The air handling requirements for ancillary systems exhausting normally non-radiological areas are evaluated on a case-by-case basis. All air cleaning systems shall be properly maintained and used, such that the effluent limits of DOE O 5400.5 are not exceeded. Filters, units, and systems that do not meet these requirements shall not be returned to service.

   C. **At the WVDP:** Exhaust blowers shall not be used to exhaust unfiltered air from surface contamination areas. To prevent the spread of radioactive contamination when using a blower in a surface contamination area, the intake to the blower shall be through a HEPA filter. Cells, hoods, and openings into containment devices should have sufficient air flow into the openings to ensure that adequate containment is achieved with an average flow exceeding 100 linear feet per minute for all in-service units. Fume hoods should operate between 100 and 125 linear feet per minute whenever possible.

   D. **At the WVDP:** Air handling, cleaning, and monitoring systems should be utilized to ensure releases to the environment and occupational exposures are maintained below the limits of 10 CFR 835, Appendix A, and DOE O 5400.5, Figure III-1.

6. **At the WVDP:** When a potential exists for airborne contamination exceeding one DAC, unconfined collection tanks shall be vented through a HEPA filter and, if necessary, through a demister. Vents shall be properly located and shall be unobstructed.

7. **At the WVDP:** In situations where personnel are inadvertently exposed to concentrations of radioactivity in the air exceeding the DAC without, or with inadequate respiratory protective equipment, shall be investigated and shall receive appropriate bioassay examinations.

PART 6 Support Activities

461 Control and Monitoring of Personal Protective Equipment and Clothing

1. Except for disposable, single use items, protective clothing designated for radiological control use should be specifically identified by color, symbol, or appropriate labeling.

2. Protective clothing designated for radiological control use should not be used for non-radiological work.

3. Personal protective equipment and clothing should not be stored with personal street clothing.

4. Cleaned personal protective equipment, such as face shields and respirators, that comes into contact with the wearer's face and company-issued clothing (other than protective clothing used for contamination control purposes) should be surveyed prior to reuse. Contamination levels should be below Table 2-2 total contamination values prior to reuse.

   A. **At the WVDP:** After respiratory protection equipment is cleaned, a release survey should be performed to ensure that components are less than Table 2-2 values.

5. Laundered protective clothing should be surveyed and should meet the following criteria prior to reuse:

   A. Beta-gamma radioactivity less than 10,000 dpm/100 cm^2

   B. Alpha radioactivity less than 1,000 dpm/100 cm^2 for transuranics and other alpha emitters in the same Table 2-2 category, and less than 10,000 dpm/100cm^2 for uranium.

6. Sites and facilities are encouraged to continue efforts to reduce contamination levels on reusable personal protective equipment and clothing.

462 Laundry

1. Clothing and equipment should be laundered according to facility, color, type, and level of contamination.

2. Laundry activities should be performed using processes that control worker dose and minimize the volume of waste generated.

3. Clothing and equipment should be screened before laundering to segregate those that are damaged, present special handling problems, or require disposal.

4. Waste streams that contain soaps, detergents, solvents, or other materials which could interfere with processing large-volume liquid waste streams should be segregated for separate processing.

5. Contracting for fully licensed laundry services should be considered.

6. Cleaned personal protective equipment and laundered protective clothing should be periodically inspected. Clothing should be free of tears, separated seams, deterioration, and damage, or repaired in a manner that provides the original level of protection.

463 Decontamination

1. Radiological work permits or technical work documents should include provisions to control contamination at the source to minimize the amount of decontamination needed.

2. Work preplanning should include consideration of the handling, temporary storage, and decontamination of materials, tools, and equipment.

3. Decontamination activities should be controlled to prevent the spread of contamination.

   A. **At the WVDP:** The general decontamination plan is to reduce contaminated areas by working inward from the outer boundary or from areas of lower contamination to areas of higher contamination. If, however, there is an area that is sufficiently contaminated to cause significant radiation exposure, it is decontaminated first to reduce the exposure during the remaining decontamination procedure.

4. Water and steam are the preferred decontamination agents. Other cleaning agents should be selected based upon their effectiveness, hazardous properties, amount of waste generated, and ease of disposal.

5. Facility line management should be responsible for directing decontamination efforts.

6. **At the WVDP:** Decontamination may be required for tools, equipment, work areas, clothing, and personnel.

   A. Decontamination efforts should result in a cleaner plant, reduction in the use of protective clothing and respiratory equipment, a reduced inventory of contaminated tools and material, and often a reduction in accumulated exposures. However, by its very nature, decontamination generates radioactive waste.

   B. Alternatives to decontamination, such as disposal without decontamination or restricted use without complete decontamination, may also be considered.

7. **At the WVDP:** Tools and equipment are segregated by contamination level and then decontaminated using preplanned methods such as decontamination cleaning solution and wipes.

464 Vacuum Cleaners and Portable Air-Handling Equipment

Improper use of vacuum cleaners and portable air-handling equipment may result in the generation of airborne radioactivity, removable contamination, or high dose rates.

1. Vacuum cleaners and portable air-handling equipment used in areas established to control removable surface contamination or airborne radioactivity (except areas where only tritium is present) should be equipped with High-Efficiency Particulate Air (HEPA) filters. If the material to be vacuumed is wet enough to preclude resuspension, then HEPA filters are not necessary.

   A. **At the WVDP:** Vacuum cleaners with HEPA filters that have been efficiency tested at least annually, or whenever the filter is changed, may be used to clean items in Contamination Areas. When opening or resealing any integral part of a vacuum cleaner, the vacuum cleaner shall be efficiency tested prior to reuse.

   B. **At the WVDP:** Used HEPA filters are normally radioactive and should be disposed of as solid radioactive waste.

C. **At the WVDP:** When authorized and approved by RS, the use of portable air handling equipment and vacuum cleaners with filtration systems that do not meet HEPA standards will be controlled. Examples of these types of units include air filtration units associated with plasma arc cutting, and vacuum cleaners where the HEPA testing and certification has expired are used in cells. The use of these units will be evaluated and controlled through the work control process with the following specific requirements: *(Article 113)*

1. The inlet and exhaust are within the posted airborne radioactivity area;
2. The workplace air is monitored;
3. The airborne radioactivity levels are maintained below the RWP limiting conditions; and
4. The specific provisions for use are clearly identified in the technical work document.

2. HEPA filters used in vacuum cleaners and portable air-handling equipment should meet the applicable efficiency and construction requirements for the devices in which they are installed. The maximum flow rate of the device should not exceed the flow rate at which the HEPA filter was efficiency tested. In addition, the device should be leak tested prior to initial use, when units have undergone any type of service that may compromise the integrity of the HEPA filter or its sealing surfaces, and annually. Leak tests are conducted by injecting DOP or equivalent aerosols into the inlet of the device and measuring the DOP concentration at the inlet and outlet of the device. Maintenance and testing should be conducted in accordance with the manufacturer's instructions or site-specific procedures that meet the manufacturer's minimum requirements.

A. **At the WVDP:** PAO has been substituted for DOP.

3. Appropriate standards for system design, construction, maintenance, and testing are provided in ASME N509, Nuclear Power Plant Air- Cleaning Units and Components and N510, Testing of Nuclear Air Treatment Systems, and ASME AG-1, Code on Nuclear Air and Gas Treatment. Several of the DOE 3020 series Technical Standards (e.g., DOE-STD-3020 Specification for HEPA Filters Used by DOE Contractors, 3022, DOE HEPA Filter Test Program, 3025, Quality Assurance Inspection and Testing of HEPA Filters, & 3026, Filter Test Facility Quality Program Plan) provide additional information applicable to HEPA-filtered systems.

4. Vacuum cleaners used for radiological work should be:

A. Marked and labeled in accordance with Article 412

B. Controlled by written work authorizations

C. Controlled to prevent unauthorized use

D. Designed to ensure HEPA filter integrity under conditions of use

E. Constructed and controlled to prevent unauthorized or accidental access to the inner surfaces of the vacuum.

5. Radiation and contamination surveys should be performed periodically for vacuum cleaners in use and labels on these units should be updated. The frequency of radiation surveys should depend on the specific use of the vacuum cleaner.

6. Airborne radioactivity levels should be monitored when a vacuum cleaner is used in a high contamination area.

7. A nuclear safety review should be performed and documented prior to the use of a vacuum cleaner for fissile material.

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CHAPTER 5 RADIOLOGICAL HEALTH SUPPORT OPERATIONS

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PART 1 External Dosimetry

511 General Provisions

1. Personnel dosimetry shall be provided to and used by individuals as follows:

   A. Radiological workers who are expected to receive from external sources an effective dose of 100 millirem or more in a year or an equivalent dose to the extremities, lens of the eye, or skin of 10 percent or more of the corresponding limits specified in Table 2-1 [see 835.402(a)(1)]

   B. Declared pregnant workers who are expected to receive from external sources an equivalent dose of 50 millirem or more to the embryo/fetus during the gestation period [see 835.402(a)(2)]

   C. Occupationally exposed minors likely to receive from external sources an effective dose in excess of 50 millirem [see 835.402(a)(3)]

   D. Members of the public who enter the controlled area and are likely to receive from external sources an effective dose of 50 millirem or more in a year [see 835.402((a)(4)]

   E. Individuals entering a high or very high radiation area [see 835.402(a)(5)].

2. Neutron dosimetry shall be provided when an individual is likely to exceed any of the criteria provided in Article 511.1 from neutrons [see 835.401(b)(2) and 835.402(a and b)].

3. Dosimeters should be issued only to individuals knowledgeable of their proper use and worn only by those to whom the dosimeters were issued.

4. To minimize the number of individuals in the dosimetry program, DOE discourages the issuance of dosimeters to individuals other than those entering areas where there is a likelihood of external exposure in excess of the monitoring thresholds established in Article 511.1. Although issuing dosimeters to individuals who are not occupationally exposed to radiation can appear to be a conservative practice, it creates the impression that the wearers are occupationally exposed to radiation. Implementation of an unnecessarily broad dosimetry program is not an acceptable substitute for development of a comprehensive workplace monitoring program.

5. Individuals should return dosimeters for processing as scheduled or upon request, and should be restricted by line management from continued radiological work until dosimeters are returned.

6. Individuals should wear their primary dosimeters on the chest area, on or between the waist and the neck, or in the manner prescribed by radiological control procedures or work authorizations.

7. Film dosimeters should not be worn or taken off-site unless specifically authorized by the radiological control manager or designee.

8. DOE discourages the practice of taking thermoluminescent dosimeters (TLDs) off-site.

   A. **At the WVDP:** Each TLD badge shall be assigned to a specific individual and be stored in the designated racks provided, or worn on the job. TLDs should not be taken off site.

   B. **At the WVDP:** TLD badges should not be left in areas onsite.

9. Individuals should not wear dosimeters issued by their resident facilities while being monitored by a dosimeter at another facility unless authorized by the radiological control manager or designee.

Individuals should not expose their dosimeters to security X-ray devices, excessive heat, or medical sources of radiation.

10. An individual whose dosimeter is lost, damaged, or contaminated should place work in a safe condition, immediately exit the area, and report the occurrence to the radiological control organization. The individual should be restricted from entry into radiological areas until a review has been conducted to verify that dose limits have not been exceeded.

11. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C, "Radiation Protection Programs Guide."

12. **At the WVDP:** The Radiation Safety Manager is responsible for implementing work restrictions when necessary.

512 Technical Provisions for External Dosimetry

1. External dosimetry programs shall be adequate to demonstrate compliance with the Table 2-1 limits [see 10 CFR 835.402(b)]. External dosimetry programs implemented to meet the requirements of Article 511.1 shall be:

   A. Accredited by the DOE Laboratory Accreditation Program for Personnel Dosimetry (DOELAP) [see 835.402(b)(1)]; or

   B. Excepted from accreditation by the DOELAP Program [see 835.402(b)(1)]; or

   C. Otherwise approved by the Chief Health, Safety and Security Officer [see 835.402(b)(2)].

   DOE-STD-1095-95 specifies the requirements for accreditation of personnel external dosimetry monitoring programs by DOELAP. A technical basis document should be developed and maintained for the external dosimetry program. Personnel external dosimeters include, but are not limited to, TLDs, track etch dosimeters, film badges, and neutron sensitive film.

2. The technical basis document should also address dosimeters monitoring radiation outside the scope of DOELAP, such as dosimetry associated with high-energy accelerators and extremity dosimeters.

   A. **At the WVDP:** WVDP-071, "WVDP External Dosimetry Program Manual and Technical Basis Document," and WVDP-401, "External Dosimetry Program Quality Assurance Plan," is established and maintained for defining the technical basis, operating procedures, and the management responsibilities associated with fulfilling quality assurance requirements relating to external dosimetry and the DOELAP requirements.

   B. **At the WVDP:** The need for extremity dosimeters shall be evaluated by RCTs or the dosimetry office staff.

   C. **At the WVDP:** In situations where exposure rates to the extremities exceed exposure rates to the whole body by a 10 to 1 ratio and the total extremity exposure is expected to be greater than 100 mrem, or, the anticipated monthly extremity dose could exceed 1 rem, extremity dosimeters shall be required.

   D. **At the WVDP:** Extremity dosimeters are accredited under DOELAP and are addressed in WVDP-071.

3. Facilities are encouraged to participate in inter-comparison studies for external dosimetry programs.

4. Multiple dosimeters should be issued to individuals to assess effective dose in non-uniform radiation fields. Non-uniform radiation fields exist when the dose to a portion of the whole body will exceed the dose to the primary dosimeter by more than 50 percent and the anticipated whole body dose is greater than 100 millirem. When the radiation field is well characterized and the worker's orientation is known, relocation of the primary dosimeter is permitted in lieu of issuance of multiple dosimeters. Under such conditions, the individual's dosimeter should be relocated to the portion of the whole body likely to receive the highest dose. Dosimeter relocation should be conducted in conformance with facility procedures or specific work authorizations, such as RWPs. The technical basis document should describe the methodology used in determining the dose of record when multiple dosimeters are used and when dosimeters are relocated.

5. A dose assessment should be performed for each instance of a lost, damaged, or contaminated personnel dosimeter.

6. Monitoring programs implemented at the discretion of the contractor (i.e., for personnel monitoring that is not required by Article 511.1) need not be accredited under the DOELAP Program. Programs implemented outside the scope of the DOELAP Program should include:

   A. Documented assessment of each individual's potential occupational dose to support the decision to operate outside the DOELAP Program. Such assessments should be based upon facility design reviews, the results of a comprehensive workplace monitoring program, and, if available, the results of previous individual monitoring results.

   B. Comprehensive routine surveys of areas that may be entered by these individuals to ensure that individual doses are not likely to exceed the Article 511.1 monitoring thresholds.

513 Pocket and Electronic Dosimeters

Pocket and electronic dosimeters are supplemental dosimeters that provide real-time indication of exposure to radiation and assist in maintaining personnel doses less than administrative control levels.

1. Individuals entering a high radiation or very high radiation area shall be monitored by a supplemental dosimeter or other means of determining the individual’s effective dose during the entry (see Article 334 for entry requirements) [see 835.502(a)(2)]. Supplemental dosimeters should also be issued when planned activities could cause an individual to exceed 50 millirem or 10 percent of a facility administrative control level from external gamma radiation in 1 work day, whichever is greater, or when required by a radiological work permit. Pocket dosimeters should be selected with the lowest range applicable (typically 0-200 mR) for anticipated personnel exposures.

2. Supplemental dosimeters should be worn simultaneously with the primary dosimeter and located in accordance with Article 511.6.

3. Supplemental dosimeters should be read periodically while in use and should not be allowed to exceed 75 percent of full scale.

4. Work authorized by written authorization should be stopped when supplemental dosimeter readings indicate total dose or rate of exposure substantially greater than planned. The radiological control organization should be consulted prior to continuation of work.

5. The energy dependence and radiation sensitivity of supplemental dosimeters, particularly to low-energy beta and neutron radiation, should be considered in determining their applicability.

6. DOE encourages the use of electronic dosimeters for entry into high radiation areas or when planned doses greater than 100 millirem in 1 work day are expected. An electronic dosimeter provides an early

warning of elevated exposure through the use of alarm set points at specified dose rates or integrated doses.

7. When the dose results from the pocket or electronic dosimeters differ by more than 50 percent from the primary dosimeter result and the primary dosimeter result is greater than 100 millirem, an investigation should be initiated to explain the difference.

514 Area Monitoring Dosimeters

Establishment and maintenance of a comprehensive area monitoring program can minimize the number of areas requiring the issuance of personnel dosimeters and demonstrate that doses outside radiological areas are negligible. Minimizing the number of personnel dosimeters issued saves in the costs of operating the dosimetry program and reduces costs associated with maintaining personnel with enhanced training and qualifications.

1. Area monitoring dosimeters may be used to record and document radiation levels in routinely occupied areas adjacent to areas where radiation or operations with radiation exist. This monitoring provision does not apply when the radiation arises solely from low-energy beta sources (e.g., Carbon-14 or tritium).

2. Area monitoring dosimeter results may be used to support dosimetry investigations where individuals express concerns about their work environments and exposure to ionizing radiation.

3. Area monitoring dosimeters may be used in controlled areas to supplement existing monitoring programs and to provide data in the event of an emergency.

515 Nuclear Accident Dosimeters

1. Facilities that possess fissile materials in sufficient quantities to create a critical mass such that the potential exists for excessive exposure of individuals in an accident shall provide nuclear accident dosimetry to affected individuals [see 835.1304(a)].

2. The nuclear accident dosimetry system shall include the following:

   A. A method to conduct initial screening of potentially exposed individuals to identify those who have received significant doses [see 835.1304(b)(1)]

   B. Equipment and methods sufficient to analyze appropriate biological samples [see 835.1304(b)(2)] and dosimeters

   C. A system of fixed nuclear accident dosimeter units [see 835.1304(b)(3)] capable of measuring the estimated neutron dose and approximate neutron spectrum

   D. Personnel nuclear accident dosimeters [see 835.1304(b)(4)].

3. The fixed dosimeters discussed above should:

   A. Be capable of determining the neutron dose from 10 rads to approximately 10,000 rads with an accuracy of ± 25%

   B. Be capable of measuring fission gamma radiation from 10 rads to approximately 10,000 rads in the presence of neutron radiation with an accuracy of approximately ± 25%.

4. Personnel nuclear accident dosimeters should be capable of measuring an absorbed dose in or on a phantom from 10 rads to approximately 1,000 rads with an accuracy of ± 25%.

5. An analysis of the fixed dosimetry system needs should be documented and should consider such factors as the nature of operations, structural design of the facility, area accessibility, number of dosimeters and their location, and the effect of intervening shielding. The analysis should be reevaluated as necessary to ensure facility modifications do not impair the capabilities of the fixed dosimetry system.

PART 2 Internal Dosimetry

521 General Provisions

1. The following individuals shall participate in an internal dosimetry program:

   A. Radiological workers who are likely to receive a committed effective dose of 100 millirem or more from all radionuclide intakes in a year [see 835.402(c)(1)]

   B. Declared pregnant workers likely to receive intakes resulting in an equivalent dose to the embryo/fetus of 50 millirem or more during the gestation period [see 835.402(c)(2)]

   C. Occupationally exposed minors likely to receive a committed effective dose in excess of 50 millirem from all radionuclide intakes in a year [see 835.402(c)(3)].

   D. Members of the public who enter a controlled area and are likely to receive an intake resulting in a committed effective dose exceeding 50 millirem in a year [see 835.402(c)(4)].

2. The estimation of internal dose shall be based on bioassay data rather than air concentration values unless one of the following conditions exists [see 835.209(b)]:

   A. bioassay data are unavailable

   B. bioassay data are inadequate

   C. internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.

3. Individuals should participate in follow-up bioassay monitoring when their routine bioassay results indicate an intake in the current year with a committed effective dose of 100 millirem or more.

   A. **At the WVDP:** Internal dose shall be assigned to workers or others where an intake of radioactive material has been confirmed by positive bioassay results or other recognized radiological methodology in accordance with established requirements.

   B. **At the WVDP:** Recording of internal dose (committed effective dose or committed equivalent dose) is not required for any monitoring result estimated to correspond to an individual receiving less than 10 mrem committed effective dose. The bioassay or air monitoring result used to make the estimate shall be maintained in accordance with 10 CFR 835.703(b) and the unrecorded internal dose estimated for any individual in a year shall not exceed the applicable monitoring threshold at 10 CFR 835.402(c). [see 10 CFR 835.702(b)]

4. Individuals whose routine duties may involve exposure to surface or airborne contamination or to radionuclides readily absorbed through the skin, such as tritium, should be considered for participation in the bioassay program.

   A. **At the WVDP:** Workers or any other personnel who are involved in an incident or accident where potential absorption, inhalation, or ingestion of radioactive materials is possible, should be provided appropriate internal dosimetry assessments as soon as possible. For those situations where significant quantities of radioactive material are ingested or inhaled, or there is severe external exposure, prompt medical treatment should be instituted as recommended by the WVDP Site Occupational Medical Director.

5. The bioassay program should establish appropriate frequencies for the collection of bioassay samples, such as urine or fecal samples, and participation in bioassay monitoring, such as whole body or lung counting. Individuals should participate at the frequency required by the bioassay program.

6. Individuals should be notified promptly of positive bioassay results and the results of dose assessments and subsequent refinements. Dose assessment results shall be provided in terms of rem or millirem [see 835.2(b), dose term definitions, and 835.4].

7. **At the WVDP:** When any person has an internal deposition of a radionuclide that was medically administered or implanted, the Radiation Safety organization should be informed when the person returns to the site, so that appropriate measures can be taken. All persons who have received medical radionuclides and who alarm the portal monitors, personnel contamination monitors, or friskers should have their TLD badge pulled until they can successfully pass through the automated monitor or with the frisker (i.e. with no alarms).

8. **At the WVDP:** Employees who work with radioactive materials shall report any skin breaks that they may have to their immediate supervisor and the Radiation Safety organization before entering a contaminated area. Employee Health Services personnel shall be consulted if there are any questions regarding employee well-being under the above circumstances.

   A. If entry into contamination areas is required, Employee Health Services personnel should provide a dressing or other protection for the skin break, if deemed advisable by the Radiation Safety organization.

   B. If approval to perform certain work is contingent upon maintaining the protection afforded by a dressing, the individual should not be allowed to enter a contamination area.

   C. The Radiation Safety organization shall ensure that the protection afforded the skin break is adequate for the nature of the work to be performed considering the potential or existing contamination status of the work location.

9. **At the WVDP:** Safeguards shall be maintained by workers and supervision to minimize the likelihood of accidental introduction of radioactive materials beneath the skin.

   A. If the skin is broken while working with radioactive materials, the employee shall exit the work area, and report to the Radiation Safety organization immediately.

   B. The Radiation Safety organization should survey the skin break and inform dosimetry office personnel for determining if additional follow-up actions are required.

10. **At the WVDP:** If a patient arrives at Employee Health Services with a site injury, the administering doctor or nurse shall ascertain if the patient was injured in a radiological area. If so, the doctor or site nurse shall notify the patient's supervisor and the Radiation Safety organization, who shall promptly review the case and initiate follow-up actions as required.

11. **At the WVDP:** When the exposure status of an individual is placed in question by a confirmed bioassay result where internal dose is assigned, involvement in a radiological incident, or any unusual circumstances, a special dose evaluation shall be performed by the dosimetry office to determine and document the individual's exposure status. The response time necessary to adequately perform follow-up actions shall be considered and identified in the establishment of the action criteria. Included in the action and response time is the need for medical intervention as defined by the attending medical staff.

12. **At the WVDP:** The determination of equivalent dose to an individual from an intake of a radionuclide proceeds from an assessment of the amount of the radionuclide in organs and tissues of the body as a function of time. The radionuclide distribution is dependent on the physical and chemical forms of the

radionuclide, its radiological properties, the physiological characteristics of the individual, the route of entry of the intake, and its magnitude.

A. The assessment of equivalent dose may be made from measurement of the radionuclide in various source organs in the body, and by application of mathematical biokinetic models to intake estimates or bioassay measurements.

B. Retrospective assessments of internal dose shall be based primarily on bioassay measurement data per Article 521.2. However, if bioassay data are not available, assessments may need to be based on air sample measurements, nasal smears, or other relevant radiological data.

C. Evaluation of exposure to internal radionuclides should account for all possible sites of deposition and their associated retention times in the body. All organ doses contributing to the effective dose should be considered rather than only those in which the radionuclide can be readily measured.

522 Technical Provisions for Internal Dosimetry

1. All bioassay programs implemented to demonstrate compliance with Article 521.1 shall be:

A. Accredited by the DOE Laboratory Accreditation Program for Bioassay Programs [see 835.402(d)]; or

B. Excepted from accreditation by the DOELAP Program [see 835.402(d)(1)]; or

C. Otherwise approved by the Chief Health, Safety and Security Officer [see 835.402(d)(2)].

2. A technical basis document should be developed for the internal dosimetry program.

A. **At the WVDP:** Details of the Internal Dosimetry Program have been implemented in WVDP-070, "WVDP Internal Dosimetry Program Manual and Technical Basis Document," and WVDP-390, “Internal Dosimetry Program Quality Assurance Plan.” These manuals shall be maintained by the Radiation Safety organization.

3. Baseline bioassay monitoring of individuals who are likely to receive intakes resulting in a committed effective dose greater than 100 millirem in a year should be conducted before they begin work that may expose them to internal radiation exposure.

A. **At the WVDP:** Appropriate baseline samples and measurements shall be obtained from all new hires who should be placed on routine bioassay programs. When there is reason to suspect previous internal contamination, results of these measurements should be available and reviewed before the new hire begins actually working with radionuclides.

B. **At the WVDP:** Individuals required to be included in the routine *In Vitro* program during their residence at the WVDP, shall submit urine samples for radionuclide analysis as required by the dosimetry office.

4. Routine bioassay monitoring methods and frequencies should be established for individuals who are likely to receive intakes resulting in a committed effective dose greater than 100 millirem in a year. The technical basis for the methods and frequency of bioassay monitoring should be documented.

A. **At the WVDP:** Routine bioassay measurements are classified as follows:

1. Scheduled periodic bioassays to detect intakes or reconfirm compliance on periodic bases. This may also provide information on the effectiveness of workplace monitoring programs.

2. Termination bioassays document the status of radionuclide deposition at the time of termination of employment or transfer from active radioactive work.

B. **At the WVDP:** The choice of bioassay sampling frequency should depend upon the following:

1. The purpose of the measurement, i.e., to detect chronic intakes, potential acute intakes undetected by first-line monitoring methods, or acute intakes that occur simultaneously with a chronic background;

2. The desire to meet the required dose objective i.e., 100 mrem;

3. Minimum detectable activities (MDA) for the various radionuclides and bioassay measurements;

4. The likelihood and ratios of combinations of radionuclides associated with an intake at a particular facility and/or task.

C. **At the WVDP:** The bioassay measurement frequency used is based on two criteria:

1. The potential nature of exposures (acute versus low-level chronic);

2. The "missed dose" concept.

The "missed dose" concept should be the basis for the design of a routine bioassay program. This concept refers to the dose that would be "missed" or unaccounted for at a given bioassay frequency.

D. **At the WVDP:** The Radiation Safety organization shall ensure that an adequate routine and special *In Vivo* and *In Vitro* program is in place and that employees are evaluated by whole body examination or collection and analysis of urine and fecal samples, respectively, as dictated by their level of risk of internal exposure.

5. Management should request termination bioassay monitoring when an individual who participated in the bioassay program terminates employment or concludes work involving the potential for internal exposure.

A. **At the WVDP:** Termination bioassays shall be made to document the status of radionuclides in the body at the time of termination of employment. and shall be used to document worker exposure status at the time of termination. Termination bioassay data may indicate the need for long-term follow up to quantify the deposition and estimate the effective dose.

B. **At the WVDP:** For a subcontractor or subcontract personnel, the cognizant engineer is responsible for scheduling exiting *In Vivo* (whole body) counts and obtaining *In Vitro* (urine) sample bottles for exiting urinalysis from the dosimetry office, if necessary.

6. Bioassay analyses should also be performed when any of the following occurs:

A. Facial or nasal contamination is detected that indicates a potential for internal contamination exceeding any monitoring threshold established in Article 521.1

B. Airborne monitoring indicates the potential for intakes exceeding 100 millirem committed effective dose

C. Upon direction of the radiological control organization when an intake is suspected.

7. Levels of intakes that warrant the consideration of medical intervention should be established for site-specific radionuclides. The effectiveness of medical intervention, such as blocking or chelating agents, should be documented using bioassay results.

8. A preliminary assessment of intakes detected should be conducted prior to permitting an employee to return to radiological work.

9. Internal dosimetry program personnel should use radionuclide standards from or traceable to the National Institute of Standards and Technology (NIST).

10. Internal dosimetry program personnel are encouraged to participate in inter-comparison studies and to use the "DOE Phantom Library."

11. Bioassay programs implemented at the discretion of the contractor (i.e., for personnel monitoring that is not required by Article 521.1) need not be accredited under the DOELAP Program. Programs implemented outside the scope of the DOELAP Program should include:

A. Documented assessment of each individual's potential occupational exposure to support the decision to operate outside the DOELAP Program.

B. Comprehensive monitoring of the areas that may be entered by these individuals to ensure that individual doses are not likely to exceed the Article 521.1 monitoring thresholds.

12. **At the WVDP:** The results of workplace airborne radioactive material measurements can be used for indicating the need for bioassay measurements. If the workplace measurements are not reasonably representative of the worker's exposure, enhanced personnel monitoring should be provided.

523 Technical Provisions for Dose Assessment

Interpretations of bioassay results and subsequent dose assessments should be documented. Detailed technical guidance for performing and documenting dose assessments is contained in DOE Standard 1121-2008, “Internal Dosimetry.”

PART 3 Respiratory Protection Program

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied air respirators, self-contained breathing apparatus, and airline supplied-air suits and hoods.

531 General Provisions

1. Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source [see 29 CFR 1910.134, Occupational Safety and Health Standards].

2. 29 CFR 1910.134 establishes requirements for respiratory protection program that are applicable to most DOE facilities. ANSI Z88.2, Practices for Respiratory Protection, provides acceptable detailed guidance for implementation of the respiratory protection program and associated training of personnel.

3. Respirators shall be issued only to individuals who are trained, fitted, and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually [see 29 CFR 1910.134 and ANSI Z88.2].

4. Positive controls should be maintained for the issue, use, and return of respirators to ensure that only qualified individuals wear respirators.

   A. **At the WVDP:** Respiratory protection equipment requirements for airborne radioactive materials should be specified on RWPs.

   B. **At the WVDP:** Individuals shall obtain respirators and return respirators after use as prescribed in standard operating procedures.

5. 29 CFR 1910.134 mandates that breathing air meet the specifications of ANSI/CGA G-7.1 Grade D breathing air. Compressed air supplied to respirators shall be tested quarterly. Compressors shall be of the breathing air type and shall not allow oil or other chemicals and fumes to enter the breathing air supply. Special attention shall be focused on the location of compressor air supply intakes and on cross-connections to other compressed gas systems to prevent contamination [see 29 CFR 1910.134].

6. Facility safety analyses should not take credit for the use of respiratory protection for routine work involving potential exposure to airborne radioactive materials.

7. **At the WVDP:** Personnel shall not be routinely exposed to airborne radioactive materials.

   A. Appropriate respiratory protection devices shall be required for entry into an Airborne Radioactivity Area if average airborne radioactivity concentrations exceed the Derived Air Concentrations.

   B. Respiratory protection may be required, as determined by the Radiation Safety organization, when the average airborne radioactivity concentration is less than the Derived Air Concentrations depending on the type and characteristics of the work activity to be performed.

   C. The required type of respiratory protection equipment shall be selected based on the average airborne radioactivity concentrations.

8. **At the WVDP:** During plant emergencies, a self contained breathing apparatus (SCBA) is the minimal respiratory protection required when entering an unknown atmosphere. This requirement shall apply until the atmosphere has been appropriately evaluated.

A. Emergency and Rescue teams that may use SCBAs for the purpose of responding to emergencies and rescues shall be trained in accordance with WVDP-179.

B. SCBA practical training shall be conducted for Emergency and Rescue teams by the Radiation Safety organization or the Industrial Safety Organization, or, by an appropriately trained supervisor or training coordinator/instructor, who is currently qualified and has been evaluated and has successfully completed SCBA practical training by the Radiation Safety or Industrial Safety Organization training coordinator(s).

9. **At the WVDP:** Assigned protection factors listed in WVDP-179 shall be followed. For atmospheres containing concentrations of tritium in vapor form greater than 1 DAC when averaged over the total time for the work activity performed or one work week (40 hours), whichever is shorter, worker protection shall be afforded by a vapor-impermeable suit with a supplied-air respirator.

532 Medical Assessment

Each prospective respirator wearer shall have a medical assessment prior to being fit-tested. The medical assessment shall determine if an employee's medical condition precludes the use of respirators and should follow the guidance in ANSI Z88.6 on frequency and content of the examination [see 20 CFR 1910.134 and ANSI Z88.2]. The ability of an employee to accommodate the additional stress placed on the body when working in a respirator is part of this assessment.

533 Use of Respiratory Protection

The use of respiratory protection devices can impair worker mobility and vision and cause worker discomfort and stress. For these reasons, the issue and use of respiratory protective devices must be controlled.

1. Individuals using respiratory protection shall:

   A. Perform fit checks of close-fitting respirators to ensure a proper seal before entering areas requiring respirator use

   B. Be clean shaven in the area of fit, if applicable

   C. Use corrective lenses, if needed, that are approved for respirators

   D. Be trained to leave the work area when experiencing respirator failure

   E. Be trained to remove their respirators to avoid life-threatening situations when exiting an area after respirator failure [see 29 CFR 1910.134 and ANSI Z88.2].

534 Heat Stress

Heat stress may result from working in areas of high heat, humidity, and radiant heat; working in protective clothing; and using respirators, particularly where other protective equipment is required. Heat stress has occurred at ambient temperatures less than 70°F when multiple sets of anti-contamination clothing or plastic suits were in use or strenuous work was required.

1. The planning stages for work in hot environments should address heat stress controls, as applicable.

2. Job supervisors should inform their personnel of heat stress precautions prior to work on job assignments in hot environments. Precautions that should be considered during work that includes a high probability of heat stress include:

A. Engineering controls to moderate the work area environment;

B. Appropriate work time limits;

C. Use of protective clothing made of materials that wick perspiration away from the body;

D. Use of body cooling devices;

E. Provision of beverages at or near the work site, using appropriate contamination controls;

F. Relaxation of protective clothing requirements.

3. If an individual begins to feel symptoms of heat illness, the individual should immediately notify the nearest co-worker, exit the area, remove personal protective equipment, notify the supervisor, and rest in a cool area. In such cases, medical assistance should be provided.

535 Half-Face Respirators

Half-face respirators have limited applications because of the design of the facial seal area. As a result, their permitted protection factor is low. Full-face respirators are generally preferred over half-face respirators because of the significant increase in protection offered with minimal loss of worker comfort.

1. The use of half-face respirators is permitted in situations where intakes of radioactive material will be low, such as those resulting in a few millirem, and where industrial and safety considerations warrant, such as during the operation of heavy equipment.

2. Due to the limited protection afforded by half-face respirators, DOE discourages the use of half-face respirators for emergency evacuation purposes.

PART 4 Handling Radiologically Contaminated Personnel

541 Skin Contamination

1. Survey techniques should be established to determine the extent of skin contamination.

2. When personnel detect skin contamination, they should notify the radiological control organization.

3. The extent of skin contamination should be determined prior to initiating decontamination procedures.

   A. **At the WVDP:** Decontamination should be initiated as soon as practicable to reduce dose to the individual(s). This action may be concurrent with further action to determine the extent of skin contamination. Contaminants should be retained, as practicable, to aid in the analysis process. Skin contamination measurements will be used to evaluate dose.

4. Skin decontamination methods should be established for site-specific radionuclides. Skin abrasion should be avoided during the decontamination process. Intrusive decontamination methods, such as tissue removal, require medical assistance.

   A. **At the WVDP:** Decontamination efforts should be performed in accordance with approved radiological control procedures and accepted practices such as that described in NCRP No. 65 and the Radiological Health Handbook.

   B. **At the WVDP:** The Radiation Safety Manager may allow a contaminated employee to go home when, in his/her judgment, further decontamination effort would be counterproductive and there is no significant radiological hazard to the public. Suitable contamination control measures shall be documented, invoked, and appropriate follow-up shall be continued until all detectable contamination has been removed.

5. Levels of skin contamination that trigger the need for dose assessments should be established for site-specific radionuclides. These trigger levels should not exceed 100 millirem.

   A. **At the WVDP:** Dose assessments shall be performed for a level of skin contamination that would result in a dose greater than 10 mrem per Appendix 2C.

6. Individuals with skin contamination that triggers the need for dose assessment should be informed of the initial dose estimate to their skin as soon as practicable, preferably prior to the end of their work day.

7. Individuals with skin contamination for which dose assessment was not performed should be informed of the nature of the contamination and an upper estimate on the potential dose (such as less than 10 millirem) as soon as practicable, preferably prior to the end of their work day.

8. An assessment of skin exposure requires time to conduct a detailed evaluation. Requirements for assessments are provided in Appendix 2C. Promptly after completion, the results should be explained to the persons affected.

542 Contaminated Wounds

1. Emergency medical care should be administered immediately for injuries involving radioactive materials. National Council on Radiation Protection and Measurements Report Number 65, Management of Persons Accidentally Contaminated with Radionuclides, contains applicable information. Medical treatment of injuries takes precedence over radiological control considerations.

A. **At the WVDP:** While all injuries sustained on the job are to be reported immediately to appropriate supervisory and safety personnel, it is particularly important to report injuries where radioactive materials are involved.

B. **At the WVDP:** RCTs should survey injuries as carefully and closely as possible to determine the extent of contamination. However, these surveys must not interfere with medical treatment of injuries.

C. **At the WVDP:** Decontamination of wounds is advisable to reduce the possibility of internal uptake of radioactive material. However, decontamination beyond that inherent in required first aid, such as washing a minor injury or encouraging bleeding from a minor puncture wound to reduce the possibility of infection, should only be performed under the observation of competent medical personnel. Decontamination liquids and dressings should be retained for possible analysis prior to proper disposal.

D. **At the WVDP:** Special bioassay monitoring may be appropriate, depending on the type of radioactive material involved and the extent of the injury. The decision as to which type of bioassay monitoring is needed should normally be made by the internal dosimetry professional. The frequency and duration of bioassay monitoring shall also be determined by internal dosimetry.

E. **At the WVDP:** Records must be maintained for all contaminated or potentially contaminated wounds.

2. The treatment of contaminated injuries should include the following:

A. Treatment of contaminated wounds by medically qualified personnel

B. Monitoring of wounds and associated bandages for contamination, including alpha emitters if applicable

C. Identification of the radionuclides involved

D. Medical determination of the need for therapeutic intervention such as blocking or chelating agents

E. Initiation of appropriate bioassay monitoring

F. Determination of need for work restrictions.

3. An injured individual should be counseled promptly on the medical and radiological implications resulting from contaminated wounds that are likely to result in internal doses greater than 2 percent of the Table 2-1 limits. The counseling should be performed by senior radiological control and medical professionals.

543 Handling Individuals Exposed to Airborne Radioactivity

Potential intakes of radioactive material are indicated when individuals without respiratory protection are exposed to airborne radioactivity or when respiratory protection has been compromised. If intakes of radioactive material are indicated which could result in an individual receiving a committed effective dose greater than 100 millirem, the following actions should be taken:

1. Identify individuals potentially exposed to airborne radioactivity

2. Obtain nasal smears for qualitative indication of intakes where appropriate

3. Analyze air samples to determine airborne concentrations where appropriate

4. Determine duration of potential exposure to airborne radioactivity

5. Perform bioassay appropriate for the type and quantity of radionuclides involved

6. Evaluate dose prior to permitting the worker to return to radiological work.

PART 5 Radiological Monitoring

551 General Provisions

Workplace monitoring provides a basis for posting and labeling, development of RWPs and other work authorizations, implementation of ALARA measures, issuance of individual monitoring devices, and verification of the efficacy of design measures and engineering controls. Development of a workplace monitoring program sufficient to meet the provisions of this chapter should include consideration of these factors to ensure the adequacy of the program.

1. Radiological monitoring of radiation exposure levels, contamination, and airborne radioactivity shall be conducted to:

   A. Characterize workplace conditions and detect changes in those conditions [see 835.401(a)(2) & (3)]

   B. Verify the effectiveness of engineered and administrative controls [see 835.401(a)(5)]

   C. Demonstrate regulatory compliance [see 835.401(a)(1)]

   D. Detect the gradual buildup of radioactive material in the workplace [see 835.401(a)(4)]

   E. Identify and control potential sources of personnel exposure [see 835.401(a)(6)]

   F Determine exposure rates during each entry to a high or very high radiation area [see 835.502(a)(1)].

2. Monitoring shall be performed only by individuals who have the appropriate education, training, and skills [see 835.103]. The instruments used shall be [see 835.401(b)]:

   A. Periodically maintained and calibrated

   B. Appropriate for the types, levels, and energies of radiation to be detected

   C. Appropriate for existing environmental conditions

   D. Routinely tested for operability.

3. Monitoring for radiation, contamination, and airborne radioactive materials should be performed as specified in technical work documents and radiological work permits.

   A. **At the WVDP:** Radiological areas that are established for a specific job shall be assessed each work day to ensure that radiological conditions have not significantly changed and that the radiological control boundaries are adequate.

   B. **At the WVDP:** Nuclear industry experience has shown that personnel performing radiation surveys sometimes receive more radiation exposure than the workers who perform the job. Monitoring personnel have a responsibility for limiting their own exposure ALARA.

4. The radiological control organization should perform and document a review of the adequacy of sampling and monitoring programs as part of any facility or operational changes affecting radiological control. In the absence of such changes, a review should be conducted annually.

5. Instruments used to perform radiation monitoring should be performance-checked daily or, if not checked within the past 24 hours, prior to operation. When performance checks are not within ±20 percent of the expected value, the instrument should be taken out of service. When performance checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance.

6. Monitoring of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries.

7. Monitoring should be performed before, during, and at the completion of work that has the potential for causing changes in levels of radiation and radioactivity.

   A. **At the WVDP:** Radiological surveys shall be made by qualified RCTs to determine whether abnormal radiological levels exist and to determine the extent and magnitude of these levels.

8. Monitoring frequencies should be established based on potential radiological conditions, probability of change in conditions, and area occupancy factors.

   A. **At the WVDP:** Radiological surveys shall be performed in accordance with a prescribed and documented schedule and approved radiological control procedures.

   B. **At the WVDP:** Radiological surveys shall be performed in spaces surrounding radiological areas, including spaces above and below them, if applicable, subsequent to movement of radioactive equipment or material. The boundaries shall be adjusted as necessary.

9. Monitoring results should be reviewed by the cognizant radiological control supervisor to ensure that all required surveys have been performed and that the documentation is accurate and complete.

10. Results of current surveys or survey maps should be conspicuously posted to inform personnel of the radiological conditions.

    A. **At the WVDP:** Appropriate radiological posting with dose rate or contamination level ranges or the RWP posted at the job site with dose rate and contamination levels or ranges indicated satisfies this requirement [*Article 113*].

11. Survey results should be made available to line management and used in support of pre- and post-job evaluations, preparation or selection of appropriate radiological work permits, ALARA preplanning, contamination control, and management of radiological control operations.

12. Monitoring data in each building or area should be compiled and reviewed at least quarterly. Changes or trends should be noted and corrective actions assigned.

13. **At the WVDP:** Only personnel trained in the use of radiation detection equipment shall be allowed to use this equipment. Such training shall be performed in accordance with an approved lesson plan and may consist of instruction and demonstration on the use of an instrument and the meaning of its measurements. Cognizant supervisory personnel are responsible to ensure that personnel using the instruments are adequately trained.

552 Radiation Exposure Monitoring

1. In addition to the requirements of Article 551, routine radiation monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based upon facility-specific experience:

   A. Daily, in office space located in radiological buffer areas and other areas surrounding radiological areas where the potential exists for external radiation exposure

   B. Weekly, in routinely occupied radiological buffer areas and radiation areas

   C. Weekly, for operating HEPA-filtered ventilation units

   D. Weekly, for temporary radiation area boundaries to ensure that radiation areas do not extend beyond posted boundaries

   E. Monthly, or upon entry, if entries are less frequent than monthly, for radioactive material areas

   F. Monthly, for potentially contaminated ducts, piping, and hoses in use outside radiological facilities.

      At the WVDP: For the SGN sample transfer system, a radiological survey shall be performed upon opening the system for use, and, on a routine basis at the system end points and locations in accessible aisleways occupied by workers, which are located within radiologically posted areas. [*Article 113]*

2. Radiation monitoring should include dose rate measurements of the general area, dose rates at a distance of 30 centimeters from a source or surface of interest to evaluate potential whole body exposures, and dose rates on contact with potential sources of radiation where there is a potential for hands-on work or other direct contact.

3. Monitoring should be conducted whenever operations are being performed that might result in individuals being exposed to small intense beams of radiation, such as those generated by shielded X-ray devices or due to removal or alteration of shielding, modification of shielding penetrations, or relocation of significant radiation sources within shielded enclosures.

4. When radioactive material exceeding a Type A quantity (as defined in 10 CFR 71) is received, radiation monitoring of the received packages shall performed if:

   A. The package is labeled in accordance with the applicable transportation requirements (e.g., Radioactive White I or Yellow II or III label) [see 835.405(b)(1)]; or

   B. The package has been transported as low specific activity material on an exclusive vehicle [see 835.405(b)(2)].

   The external surfaces of all packages received from transportation should be monitored to determine the external radiation level, unless the packaged materials are not capable of creating an external radiation hazard (i.e., the packages contains only materials that emit radiation of low penetrating ability). These surveys are used to ensure compliance with Department of Transportation regulations and applicable DOE Orders and to identify appropriate postings and access control measures. These measures should be established as soon as practicable after receipt.

5. Monitoring shall also be performed when a received package containing greater than a Type A quantity of radioactive material shows evidence of degradation, such as packages that are crushed, wet, or damaged [see 835.405(b)(3)].

6. Monitoring of received packages of radioactive material shall be performed as soon as practicable following receipt, but not later than eight hours following the beginning of the working day following the receipt of the package [see 835.405(d)].

7. Monitoring is not required for packages transported on a DOE site which have remained under the continuous observation and control of a DOE employee or DOE contractor employee who is knowledgeable of and implements required exposure control measures [see 835.405(e)].

8. See Articles 554 for additional provisions for radioactive material receipt.

553 Area Radiation Monitors

1. In addition to the requirements and recommendations of Article 551, area radiation monitors (not to include area monitoring dosimeters discussed in Article 514) should be installed in frequently occupied locations with the potential for unexpected increases in dose rates and in remote locations where there is a need for local indication of dose rates prior to personnel entry.

2. Area radiation monitors should not be substituted for radiation exposure surveys in characterizing a workplace.

3. The need for and placement of area radiation monitors should be documented and assessed when changes to facilities, systems, or equipment occur.

4. In addition to the requirements of Article 562, area radiation monitors should be tested periodically (e.g., quarterly) to verify audible alarm system operability and audibility under ambient working conditions and operability of visual alarms when so equipped.

   A. **At the WVDP:** Area Radiation Monitors installed for the purpose of process monitoring are exempt from these requirements.

5. If installed instrumentation is removed from service for maintenance or calibration, a radiation monitoring program providing similar detection capability should be provided, consistent with the potential for unexpected increases in radiation dose rates.

6. Where an area radiation monitor is incorporated into a safety interlock system, the circuitry should be such that a failure of the monitor either prevents entry into the area or prevents operation of the radiation producing device. If the circuitry is required to ensure compliance with the high radiation area access control requirements of 10 CFR 835.502, then the circuitry shall be fail-safe [see 825.502(b)].

554 Contamination Monitoring

1. In addition to the requirements of Article 551, contamination monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based upon facility-specific experience:

   A. Prior to transfer of equipment and material from one radiological buffer area established for contamination control to another, unless the material was monitored immediately prior to this transfer, such as upon removal from a contamination area

B. Prior to transfer of equipment and material from high contamination areas within radiological buffer areas unless precautions such as bagging or wrapping are taken prior to transfer

C. Daily, at contamination area control points, change areas, or step-off pads when in use, or per shift in high use situations

D. Daily, in office space located in radiological buffer areas

E. Daily, in lunch rooms or eating areas near radiological buffer areas

F. Daily in accessible areas where operations are under way that are likely to produce hot particles

G. Weekly, in routinely occupied radiological buffer areas

H. Weekly, or upon entry if entries are less frequent, in contamination areas and other areas where materials having removable contamination exceeding the Table 2-2 values are handled or stored

I. Weekly, or upon entry if entries are less frequent, where contamination area boundaries or postings are located

J. During initial entry into a known or suspected contamination area, periodically during work, at completion of job, or as specified in a radiological work permit

K. Monthly, in and around areas of fixed contamination

At The WVDP: WVES will perform quarterly surveys of the outdoor fixed contamination areas and areas around them that are accessible and are accessed by personnel. Areas such as roof tops and walls above seven feet are controlled by Radiation Work Permits and are not accessed frequently enough to require more than an annual survey [*Article 113*].

L. After a leak or spill of radioactive materials.

2. Articles 421 and 422 provide requirements and guidance for material release surveys.

3. When radioactive material is received (other than gaseous or special form materials), contamination monitoring of the received packages shall be performed if:

A. The package is labeled in accordance with the applicable transportation requirements (e.g., Radioactive White I or Yellow II or III label) [see 835.405(b)(1)]; or

B. The package has been transported as low specific activity material on an exclusive vehicle [see 835.405(b)(2)].

The external surfaces of all packages received from transportation should be monitored to determine the external contamination level, unless the packaged materials are not capable of creating a contamination hazard (i.e., the packages contain only gaseous or special form materials). These surveys are used to ensure compliance with Department of Transportation regulations and applicable DOE Orders and to identify appropriate postings and access control measures. These measures should be established as soon as practicable after receipt.

4. Monitoring shall also be performed when a received package of radioactive material shows evidence of degradation, such as packages that are crushed, wet, or damaged [see 835.405(b)(3)], unless the packages contain only special form or gaseous radioactive material.

5. When monitoring of received packages is required (as specified in Article 554.3), monitoring shall be performed as soon as practicable following receipt, but not later than eight hours following the beginning of the working day following the receipt of the package [see 835.405(d) and 835.405(e)].

6. Contamination surveys should incorporate techniques to detect both removable and fixed contamination.

   A. **At the WVDP:** Except in fixed contamination areas or areas in which the background radiation levels do not permit a direct reading that is capable of detecting Table 2-2 values, both types of survey measurements are required [*Article 113*].

7. Swipe surveys for removable contamination should be recorded in units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2). For swipe surveys of small items covering less than 100 cm^2, the results should be recorded in units of dpm per area swiped. If contamination levels exceed the range of the available count rate meters, the swipes should be analyzed by holding an appropriate exposure rate meter within one half inch and the results should be recorded in units of millirad or rad per hour.

8. Large area wipes are encouraged and should be used to supplement standard swipe techniques in areas generally assumed not to be contaminated, such as entrances to radiological areas. If an evaluation indicates that an area wiped is contaminated, a thorough contamination swipe survey should be performed.

9. Areas identified as either contaminated with, or having the potential for being contaminated with, highly radioactive particles ("hot particles") should be surveyed using special swipe techniques to collect hot particles, such as tape and large area wipes.

10. **At the WVDP:** The Radiation Safety organization shall establish and maintain a schedule for routine contamination surveys. This schedule should define the areas to be surveyed and the frequency of the surveys. During work with radioactive material, sufficient contamination surveys shall be taken to provide assurance that contamination control is maintained.

555 Airborne Radioactivity Monitoring

1. In addition to the requirements of Article 551, air monitoring programs should be established to ensure that airborne radioactivity monitoring is performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. Selection of air monitoring equipment should be based on the specific job being monitored. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors.

   A. **At the WVDP:** In areas where the airborne radioactivity is unknown, the potential concentration of airborne radionuclides may be determined from the collection of air samples and removable radioactivity measurements by a qualified RCT prior to any access to that area.

   B. **At the WVDP:** Ambient air monitoring shall be performed in occupied areas with the potential to exceed 10 percent of any occupational DAC value as listed in 10 CFR 835, Appendix A. Air monitors should be strategically placed to detect and evaluate airborne radioactive material at a minimum detection level of one DAC when averaged over 8 hours.

2. Air sampling equipment shall be used where an individual is likely to receive an annual exposure of 40 or more Derived Air Concentration (DAC) hours [see 835.403(a)(1)]. This intake generally represents a committed effective dose to an individual of approximately 100 millirem. Samples shall also be taken as necessary to characterize the hazard in areas where respiratory protection devices have been prescribed for protection against airborne radionuclides [see 835.403(a)(2)]. Air samples should be adequate to evaluate the concentrations of airborne radioactive materials at the individual's work locations.

A. **At the WVDP:** There are stationary air samplers located throughout the accessible areas of the site and many are located in routine work areas. These samplers draw air through a filter at a constant flow rate and are initially counted when changed to determine if there are any apparent problems that require immediate attention and then held for a week until the short-lived radionuclides decay and then recounted for alpha and beta activity. The results should be used to assess the status of the monitored areas for unplanned changes.

B. **At the WVDP:** The number and type of samplers, their location, the frequency of filter change, as well as other variables should be established and maintained by the Radiation Safety organization.

3. Real-time (or continuous) air monitors are used to provide early warning to individuals of events that could lead to substantial unplanned exposures to airborne radioactivity. Such exposures could result from a breakdown of engineered controls or improper establishment of boundaries during work that creates airborne radioactivity. Real-time air monitoring shall be conducted as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material [see 835.403(b)].

   A. **At the WVDP:** Continuous air monitors (CAMs) shall have visual and audible alarms. The WVDP should endeavor to have CAM alarms set as close to 8 DAC-hours as is possible.

4. Air sampling equipment should be positioned to measure air concentrations to which individuals are exposed. If this cannot be achieved, a program of personal breathing-zone air sampling should be initiated.

5. Air monitoring equipment shall be routinely calibrated and maintained on an established frequency [see 835.401(b)]. Air monitoring equipment should be calibrated at least once each year. Continuous air monitors should be capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions.

6. Real-time air monitoring equipment required by Article 555.3 should have alarm capability and sufficient sensitivity to alert individuals that immediate action is necessary to minimize or terminate inhalation exposures.

7. A technical basis document should be developed for the airborne radioactivity monitoring program. The technical basis document should provide the basis for air monitor selection, placement, and operation.

   A. **At the WVDP:** WVDP-216 discusses program requirements and provides a technical basis for the workplace radiological air sampling and monitoring program.

8. The proper operation of continuous air monitoring equipment should be verified daily (e.g., by performing an operational check, or verifying the CAM is operating normally as indicated by 'power on', 'normal count-rate reading', and no 'trouble' or 'failure' alarms). Operational checks typically include positive air-flow indication, non-zero response to background activity, and internal check sources or 60 Hz electronic checks when available. Real-time air monitoring equipment operation should be verified weekly by checking for instrument response with a check source or with ambient levels of radon and thoron daughters.

   A. **At the WVDP:** The exchange of the filter with the corresponding instrument response fulfills the equipment weekly check.

9. Preliminary assessments of air samples utilizing field survey techniques should be performed promptly upon removal. In situations where background levels of radon and thoron daughters interfere with evaluation of alpha air samples, prompt field assessments may not be possible.

A. **At the WVDP:** There are three types of air samples taken: Job-specific air samples, routine air samples (i.e., Plant Tour Air Samples or PTAS), and Continuous Air Monitors (CAMs). Instead of using field survey techniques such as a GM detector or portable alpha counter (PAC), air sample filters from routine air samplers shall be collected and counted as soon as practical using a minimum of a one minute counting time on the proportional counter (or equivalent). The initial count should occur within 12 hours after collection unless authorized by the Radiation Safety Supervisor. For routine air samples, a second count should be made within 36 hours after collection unless authorized by the Radiation Safety Supervisor. The second count should be used to determine if the short-lived decay products are decreasing as historically expected for each of the facility areas. For continuous air monitors, no field survey or immediate count is required due to the chart or electronic recording and alarm capabilities of the instrument. All types of air samples shall be counted after 3 days to determine the long-lived activity remaining on the filter. *[Article 113]*

10. Air sample results should be evaluated as quickly as practicable for evaluation of the need for respiratory protection, area evacuation (if necessary), worker intake, and worker relief from respirator use.

11. Site-specific temporal and spatial averaging techniques may be used in determining the requirements for air monitoring. Justification for these techniques should be documented and retained and the results of these analyses used in documentation of the RPP.

12. Approved respirator protection factors may be considered in specifying application of CAMs if all individuals in the affected area will be wearing respiratory protection devices. This provision supplements the Department's reliance upon engineering and administrative controls for airborne radioactivity control and does not diminish the need to perform workplace monitoring as required by 10 CFR 835.401(a). In addition, the accompanying provision regarding the need to alert individuals to unexpected transients remains in effect and must be considered. Criteria requiring the use of CAMs should be fully described in the RPP.

13. Any of the various available air sampling methods (high or low flow rate grab samples, CAMs, lapel samples, etc.) may be used to demonstrate compliance with 10 CFR 835.403(a)(1). Specific guidance should be developed and provided to individuals performing the sampling (such as in site procedures) to ensure proper application of the specified method.

14. Air monitoring results may be used for determination of internal doses but only under the conditions specified in 10 CFR 835.209(c). Efforts should be made to acquire and analyze air samples using the most representative and accurate techniques that are available, considering site-specific factors such as available resources and potential for missed dose.

15. When performing air monitoring to demonstrate compliance with either 10 CFR 835.403(a)(1) or (2), the method used must be appropriate for the existing environmental conditions, consistent with 10 CFR 835.401(c)(3). Any conflicts between this requirement and the specific monitoring requirements of 10 CFR 835.403(a) should be considered in development of the RPP.

16. **At the WVDP:** When work activities require respiratory protection, the airborne radioactivity concentration and fraction of DAC shall be calculated by the Radiation Safety organization using gross alpha and gross beta-gamma airborne radioactivity measurements when the specific contribution from individual radionuclides have not yet been determined using the following expression:

$$F_{DAC} = \frac{\mu Ci/mL\ alpha}{DAC} + \frac{\mu Ci/mL\ beta-gamma}{DAC}$$

where, F_{DAC} = Fraction of DAC

A. The gross alpha limit is that of Pu-239 and Am-241 (10 CFR 835, Appendix A). Pu-239 (or Am-241) is used because it is the most abundant of the alpha emitting nuclides in the WVDP source term. It is recognized that Th-232 has a lower DAC, however, it will only be applied to gross alpha calculations for those waste streams where Th-232 is known or suspected to be present.

B. The gross beta limit is that of Sr-90 (F) because it is one of the two most abundant of the beta emitting nuclides in the WVDP source term and because it's DAC is much more restrictive than that for Cs-137, the other most abundant.

17. **At the WVDP:** The DAC values should be used when individual radionuclides have been identified and measured. The identification of specific radionuclides can be made by collecting removable residual material from surfaces in the area under investigation, or by a composite of several air filter samples for a bulk sample analysis. If either gross alpha or gross beta-gamma concentrations exceed the total isotopic alpha or beta-gamma concentrations, respectively, the difference in concentrations shall be used in the calculation. The airborne radioactivity concentration and fraction of DAC may be calculated using the "sum-of-fractions" expression as follows:

$$F_{DAC} = \Sigma_i \frac{\mu Ci/mL\ (radionuclide\ i)}{DAC\ (radionuclide\ i)} + \frac{\mu Ci/mL\ X_{alpha}}{DAC} + \frac{\mu Ci/mL\ X_{beta-gamma}}{DAC}$$

where, X_{alpha} = gross alpha minus total identified isotopic alpha

$X_{beta-gamma}$ = gross beta – gamma minus total identified isotopic beta – gamma

For respiratory protection purposes, the airborne radioactivity concentration and fraction of DAC shall be averaged over the time the work activity is performed or a normal work week (40 hours) whichever is smaller.

18. **At the WVDP:** It should be recognized that given the sophistication of present state-of-the-art air monitoring equipment, only under perfect laboratory (i.e., dust free) conditions has the measurement of 8 DAC-hours been achieved. When such equipment is placed into normal operating conditions, and is subject to multiple interferences such as dust loading and radon progeny, accurate determination of such low radioactive concentration values has not yet been achieved.

19. **At the WVDP:** Air sampling shall be performed by the Radiation Safety organization when airborne radioactivity levels greater than two percent of the DAC are likely or expected or where an individual is likely or has the potential to receive greater than 2 percent of the Annual Limit of Intake (ALI) per Article 555.2.

20. **At the WVDP:** Sampling for airborne particulate radioactivity shall be performed in any area where personnel have a likelihood for exposure to airborne radioactivity due to the radiological conditions of the area or due to specific operations being conducted in the area. Continuous air monitors may be used for this purpose.

21. **At the WVDP:** Portable airborne particulate samplers should be used in occupied areas where use of continuous air monitors is impractical due to space constraints or other factors. In such cases, the selection of respiratory protection devices should be conservative to reflect the increased uncertainty of periodic monitoring (i.e., not "real-time"). These samplers shall be routinely calibrated and maintained. They shall have the capability, between sampling time or flow and counting times, of measuring 10 percent of the upper bound for the appropriate airborne radioactivity concentration and assigned protection factor.

22. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C, "Radiation Protection Programs Guide."

PART 6 Instrumentation and Calibration

561 Standardization

DOE encourages standardization on the use of commercially-available radiological instrumentation.

562 Inspection, Calibration, and Performance Tests

1. Radiological instruments shall be used only to measure the radiation for which their calibrations are valid [see 835.401(b)(2)]. ANSI N323A, Radiation Protection Instrumentation Tests and Calibration provides appropriate comprehensive guidance for establishing and operating a radiological instrumentation calibration program. Calibrations should use National Institute of Standards and Technology (NIST) traceable sources.

   A. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C," Radiation Protection Programs Guide."

2. Calibration procedures should be developed for each radiological instrument type and should include frequency of calibration, pre-calibration requirements, primary calibration requirements, periodic performance test requirements, calibration record requirements, and maintenance requirements.

3. All radiological monitoring instruments, including pocket and electronic dosimeters and area radiation monitors, shall be maintained and calibrated on an established frequency [see 835.401(b)(1)]. Calibration frequencies should be determined in accordance with National Conference of Standards Laboratories Recommended Practice RP-1, Establishment and Adjustment of Calibration Intervals.

   A. **At the WVDP:** Minimum calibration frequencies shall be required as stated by applicable consensus standards and manufacturers recommendations. As required by ANSI N323A-1997, if greater than 10 percent of the instruments are out of calibration, consideration should be given to increasing the calibration frequency. NCSL RP-1 or other consensus standard recommendations may be used as justification in extending calibration frequencies. *[Article 113]*

4. The effects of environmental conditions, including interfering radiation, on an instrument shall be known prior to use [see 835.401(b)(3)].

   A. **At the WVDP:** In the absence of formal instrument test results, the determination of the appropriateness of radiological monitoring instruments may be made using a variety of existing information sources (e.g., design specifications, sales literature, manufacturer's tests, etc.). These documented sources of information shall be condensed into appropriate operating guidelines for the instruments.

   B. **At the WVDP:** Technical basis documents shall be developed and maintained for radiological monitoring instruments. These documents shall describe environmental conditions, types of radiations, and the energies of the radiation at the WVDP. The selection of portable survey instruments used at the WVDP shall be described in these documents. All technical basis documents shall be approved by the Radiation Safety Manager and maintained in auditable files.

5. Operational tests should be used to assess instrumentation designs that include alarms or that involve a process control. An operational test should be developed to test all components involved in an alarm or trip function and performed at least annually.

6. In unusual and limited situations it may be necessary to use an instrument in an application other than that envisioned by the manufacturer. Special calibrations should be performed for use of instrumentation

outside manufacturer's specifications. The instrument should be adjusted, calibrated, and labeled to identify the special conditions and used only under the special conditions for which it was calibrated.

7. Measures should be implemented to ensure that individuals using an instrument can verify its calibration status.

8. Instruments whose "as found" readings indicate that the instrument may have been used while out of calibration should be reported to the radiological control organization. The radiological control organization should review surveys performed with the instrument while it was out of calibration and consider the need for additional surveys.

563 Maintenance

1. A program for preventive and corrective maintenance of radiological instrumentation should be established and documented.

2. Preventive and corrective maintenance should be performed using components and procedural recommendations at least as stringent as those specified by the manufacturer of the instrument.

3. Radiological instruments should undergo calibration prior to use following any preventive or corrective maintenance or any adjustment that voids the previous calibration. A battery change is not normally considered maintenance.

564 Calibration Facilities

1. Radiological monitoring instrument inspections, calibrations, performance tests, calibration equipment selection, and quality assurance should be performed using documented protocols/procedures. ANSI N323 provides detailed technical guidance for the establishment of calibration programs.

2. For organizations that do not possess or use their own calibration facilities, contracted calibration services should be performed in accordance with the referenced standards.

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CHAPTER 6 TRAINING AND QUALIFICATION

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PART 1 Radiological Control Training and Qualification

611 Purpose

The provisions of this chapter ensure that individuals are trained to work safely in and around radiological hazards and to maintain their individual radiation exposure and the radiation exposures of others ALARA. Training provisions in this chapter apply to individuals entering controlled areas at DOE sites and other individuals who are responsible for developing and implementing radiological control measures.

1. **At the WVDP:** Requirements in this chapter take into account the guidance provided by DOE-HDBK-1131-2007 on General Employee Radiological Training (GERT), DOE-HDBK-1130-2007 Radiological Worker Training, and that of DOE-HDBK-1122-99 for Radiological Control Technician Training.

2. **At the WVDP:** The purpose of the standardized core training program is to provide a baseline of knowledge and skills in radiological fundamentals for the general employee and the radiological worker and to standardize core training at all DOE facilities. The goal of the training program is to provide a consistent level of proficiency for general employees and radiological workers across the DOE complex.

3. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C," Radiation Protection Programs Guide."

612 Standardization

10 CFR 835.901 establishes requirements for radiation safety training programs for two classes of individuals: 1) individuals who are permitted unescorted access to controlled areas or are occupationally exposed to radiation; and 2) individuals who are permitted unescorted access to radiological areas or perform unescorted assignments as a radiological worker. Within this Standard, these training programs are referred to as General Employee Radiological Training and Radiological Worker Training (I and II), respectively. In addition, 10 CFR 835.103 establishes requirements for the education, training, and skills of individuals who are responsible for developing and implementing measures necessary for ensuring compliance with 10 CFR 835. DOE sponsored the development of core courses and training materials and recommends the use of these materials to achieve consistency in the level and quality of training given Department-wide. In establishing local training programs, DOE's core courses should be utilized to the extent practicable and supplemented with site-specific information. Core course training material developed and maintained by DOE Headquarters (EH) consists of lesson plans, viewgraphs, student handbooks, qualification standards, question banks, and Program Management Guides.

1. Radiation safety training programs are necessary to ensure compliance with 10 CFR 835.901. Training programs for members of the public, general employees, and radiological workers should be developed consistent with Parts 2, 3, and 6 of this Chapter to ensure compliance with these requirements. Additional training programs consistent with those discussed in Parts 5 and 6 of this Chapter may be necessary to ensure compliance with the education, training, and skills requirements of 10 CFR 835.103. Affected individuals may include, but not be limited to, managers, supervisors, technical specialists, researchers, clerks, and engineers.

    A. **At the WVDP:** The training programs represent the minimum requirement for the standardized core materials. The WVDP shall incorporate the program in its entirety and should augment the standardized core materials to increase the general employee and radiological worker level of competency.

    B. **At the WVDP:** Augmented materials may include a further explanation of the standardized core materials and/or site specific information related to the core information. Training described in the manual does not eliminate or reduce the need for additional training.

2. DOE's core course training material, supplemented by site-specific training materials, should be used to the extent practicable to satisfy the training requirements of both 10 CFR 835.901 and 10 CFR 835.103. DOE has sponsored the development of standardized courses for:

   A. General Employee Radiological Training
   B. Radiological Worker I and II Training
   C. Radiological Control Technician Training
   D. Radiological Assessor Training
   E. Radiological Control Training for Supervisors
   F. Radiological Safety Training for Plutonium Facilities
   G. Radiological Training for Tritium Facilities
   H. Radiological Safety Training for Accelerator Facilities
   I. Radiological Safety Training for Uranium Facilities
   J. ALARA Training for Technical Support Personnel
   K. Radiological Safety Training for Radiation Producing (x-ray) Devices

3. Successful completion of the entire core academic component of a DOE core course at one DOE site within the past two years should be recognized by other DOE sites. Allowances may also be made for individuals who have successfully completed other types of radiological control training. Documentation of previous training should include the individual's name, date of training, topics covered, and name of the certifying official. However, under these circumstances, any additional radiological control training necessary for the individuals to perform radiological work or to enter specific areas, including site-specific aspects of the radiation safety training, shall be completed [see 835.901(c)]. Site-specific training for General Employee Radiological Training and Radiological Worker I and II training may be included with other site orientation training.

4. At sites where there are multiple facilities, the training may be facility-specific if personnel access is limited to those facilities for which training has been completed.

613 General Provisions

1. Radiation safety training shall include the following topics, to the extent appropriate to each individual's prior training, work assignments, and degree of exposure to potential radiological hazards:

   A. Risks of exposure to radiation and radioactive materials, including prenatal radiation exposure [see 835.901(c)(1)]

   B. Basic radiological fundamentals and radiation protection concepts [see 835.901(c)(2)]

   C. Controls, limits, policies, procedures, alarms, and other measures implemented at the facility to control doses, including both routine and emergency actions [see 835.901(c)(3)]

   D. Individual rights and responsibilities as related to implementation of the facility radiation protection program [see 835.901(c)(4)]

   E. Individual responsibilities for implementing ALARA measures [see 835.901(c)(5)]

   F. Individual exposure reports that may be requested [see 835.901(c)(6)].

2. Prior to permitting an individual to enter a radiological area unescorted or perform unescorted radiological work, training commensurate with the hazard in the area and required controls shall be completed [see 835.901(b)]. Chapter 3 provides guidance regarding the level of training appropriate for each defined area. Examinations and performance demonstrations shall be used to demonstrate satisfactory completion of initial Radiological Worker Training [see 835.901(b)]. Examinations shall be used to demonstrate satisfactory completion of biennial Radiological Worker Training and Radiological Worker

Training provided for significant changes to the radiological control program [see 835.901(e)]. Examinations should be written; however, the radiological control manager may approve alternatives to accommodate special needs. Alternative examinations should be equivalent in content to written examinations. The RCO should consider the following when developing the examination process:

A. Minimizing the number of true/false questions and not allow open-book examinations

B. Use of questions randomly selected from the question bank

C. Acknowledgment by signature that the student participated in a post-examination review

D. That competence in required skills be measured using performance-based examinations

E. Remedial actions for failure to meet the minimum score

F. Maximizing the question bank questions that test what the student is expected to remember months after the training rather than to test short term memory of theoretical material.

G. **At the WVDP:** Written examinations require a minimum passing score of 80 percent.

3. Training should address both normal and abnormal situations in radiological control.

4. General Employee Radiological Training and Radiological Worker training shall be completed at intervals not to exceed 24 months [see 835.901(e)]. This biennial training should not be limited subjects with which the students are already familiar, but should focus on applicable lessons learned and topics that will increase the students' knowledge of radiological hazards and controls. Training shall also be provided to affected individuals when there is a significant change to the radiological control program [see 835.901(e)]. Changes to the radiological control program should be incorporated into the training program on a periodic basis.

   A. **At the WVDP:** Refresher training programs for GERT, RWI, and RWII training shall be implemented on the alternate year when full training is not completed per Article 613.4. Refresher training programs are designed to maintain and enhance the proficiency of the worker. The refresher training for GERT, RWI, and RWII shall be documented and is necessary to maintain current position status. GERT, RWI, and RWII refresher training may be accomplished through a video, handout, computer based training, or classroom training. The WVDP will consider retraining employees in GERT every year when deemed necessary by the Radiation Safety organization and/or when significant changes occur in the radiological control program or WVDP facility.

   B. **At the WVDP:** The decision to retrain prior to the two year interval should be based on the practical effects of the change, and what implications there are for the work force. Small administrative changes or alterations of guidance information should not require a formal GERT retraining, but may be accomplished with the use of notices to employees or an updated GERT handbook.

   C. **At the WVDP:** The time interval to conduct radiation safety training per 10 CFR 835.901 may be extended by a period not to exceed 30 days to accommodate scheduling needs [**10 CFR 835.3(e)**].

5. Measures should be implemented to ensure that each individual's current training status can be assessed as necessary to ensure appropriate job assignments and to permit effective entry control. Appropriate measures include electronic databases or wallet-sized training certificates that identify current training status.

6. Site-specific training and refresher training should include changes in requirements and applicable updates of lessons learned from operations and maintenance experience and occurrence reporting, for the site and across the DOE complex.

7. Verification of the effectiveness of radiation safety training should be accomplished by surveying a limited subset of former students in the workplace. This verification is in addition to performance evaluations routinely performed by training departments. This evaluation should include observation of practical applications and discussions of the course material and may include written examinations. The survey should be performed by radiological control managers and supervisors, quality assurance personnel, or senior instructors after the former student has had the opportunity to perform work for several months. The results should be documented and may be used to identify the need for remedial training.

8. Training programs developed for radiation safety should meet the requirements for performance-based training.

9. Reading and comprehension skills in the English language are generally necessary for radiation safety training. The radiological control manager is authorized to approve alternative measures for those lacking reading and comprehension skills in the English language until adequate English language skills can be achieved. Training in an alternate language should be equivalent to training in English. The alternative measures should be sufficient to ensure that the affected individuals can respond appropriately to any audible or visible warnings that they may encounter in the facility. Orientation and the use of trained escorts provide an alternate to training with the concurrence of the radiological control manager.

10. Additional requirements for personnel training are established in DOE Order 5480.20A, Personnel Selection, Qualification, Training and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities.

11. The site radiological control manager or designee should concur in radiation safety training material.

12. Requirements and guidance for training records and course documentation are provided in Article 725.

614 Instructor Training and Qualifications

1. All instructors should be qualified in accordance with the contractor's site Instructor Qualification Program or possess equivalent qualifications.

2. Instructors should have the technical knowledge, experience, and instructional skills required to fulfill their assigned duties.

3. Instructors-in-training should be monitored by a qualified instructor.

4. Subject matter experts without instructor qualification may provide training in their areas of expertise. However, these subject matter experts should be trained as instructors when this occurs routinely.

PART 2 General Employee Radiological Training

Table 3-1 summarizes the requirements for those individuals who should receive General Employee Radiological Training.

621 Site Personnel

1. Individuals shall complete radiation safety training prior to unescorted access to controlled areas and prior to receiving occupational radiation exposure during access to controlled areas [see 835.901(a)]. This training shall address the radiation safety training topics in Article 613.1 to the extent appropriate for the degree of exposure to radiological hazards that may be encountered and the required controls [see 835.901(a)].

   General Employee Radiological Training should include DOE's core course training materials, as applicable, and should be expanded to include site-specific information, such as site-specific radiation types, alarm responses, and policies. This site-specific information may be included in GERT, or in facility orientations.

2. Workers may challenge General Employee Radiological Training core knowledge requirements by passing a comprehensive examination. If unsuccessful in one attempt, the entire General Employee Radiological Training standardized core training should be completed. Challenges should not apply to the site-specific portions.

3. Additional training beyond General Employee Radiological Training should be required for unescorted entry into radiological buffer areas or areas posted for radiological control other than controlled areas.

   A. **At the WVDP:** Any individual who requires access to a radiological area for any purpose and who is not a radiological worker shall be escorted by a qualified radiological worker while in the radiological area. The following requirements shall be imposed for this condition:

      1. The non-qualified individual shall not be permitted to handle, process, or work with radioactive materials, unless approved by the Radiation Safety Manager (see Article 335.10).

      2. Individuals who require entry or multiple entries into a radiological area that could result in the individual receiving greater than 100 mrem per year from the committed effective dose from internal irradiation plus the effective dose from any external irradiation, shall be a qualified radiological worker.

4. Information may be communicated by classroom lecture, videotape, or other appropriate methods.

5. In the alternate year when full training is not completed, the latest General Employee Radiological Training Handbook (Student Guide) should be available for self-study.

6. If an escort is used in lieu of training, then the escort shall have completed the level of training required for the areas to be entered and the work to be performed and shall ensure that the escorted individual complies with the radiation protection program [see 835.901(e)].

7. **At the WVDP:** All General Employees shall receive GERT within one month of their initial visit to the WVDP or prior to potential occupational radiation exposure. New employees will be continuously escorted by a trained WVDP employee until General Employee Training is received. Retraining will occur at least every two years and will include review of any new material, emergency signals and actions, evacuation routes, and staging areas.

622 Radiological Safety Training and Orientation for Members of the Public

1. Members of the public shall receive radiation safety training prior to being permitted unescorted access to controlled areas [see 835.901(b)]. This training shall address the radiation safety training topics in Article 613.1 to the extent appropriate for the degree of exposure to radiological hazards that may be encountered and the required controls [see 835.901(a)].

   A. **At the WVDP:** The radiological safety orientation is administered for personnel visiting or working onsite including contractors and subcontractors. The Plant Security Department is responsible for the orientation and ensuring that the orientation is completed.

2. DOE encourages its operating entities to continuously escort members of the public in the controlled area. However, when members of the public are trained in accordance with Article 622.1, the following additional criteria should be met prior to permitting unescorted access to controlled areas:

   A. Prior approval by the radiological control manager

   B. Appropriate limitations are established on the areas to be entered and the activities to be undertaken to prevent occupational exposure

   C. The individual receives enhanced training providing information commensurate with the areas to be entered and activities to be undertaken while unescorted.

3. Members of the public, including tour groups and visiting dignitaries, who enter the controlled area and are continuously escorted, should receive a radiological safety orientation. This orientation should include the following topics and be commensurate with the hazards present in the areas to be entered and the required controls:

   A. Risk of low-level occupational radiation exposure, including cancer and genetic effects

   B. Risk of prenatal radiation exposure

   C. Member of the public and management responsibilities for radiation safety

   D. Adherence to radiological posting and labeling

   E. Applicable emergency procedures

   F. Training for issuance of dosimeters, where applicable.

   G. **At the WVDP:** Contact the Radiation Safety organization when confronted with problems or questions dealing with radiation protection or nuclear safety.

4. Information may be communicated by classroom lecture, videotape, or other appropriate methods. An examination is not required.

5. Sign-in logs may be used as radiation safety training and orientation records as required by Article 725.

6. **At the WVDP:** Visitors are not considered General Employees and shall be continuously escorted by a person trained by the WVDP (i.e., unless granted unescorted access to a specific area). Visitors shall complete GERT when:

   A. They visit the site for more than 40 hours in a year; or

   B. The work which they are performing requires an RWP; or

C. The work which they are performing requires respiratory protection; or

D. If, in the best interest of the WVDP, it is determined necessary.

It is recommended that visitors who require access on a routine basis, more than 40 hours in a year, and require access to radiologically posted areas, should upgrade their knowledge of radiation protection and complete Radiological Worker I or II training (per Table 3-1).

PART 3 Radiological Worker Training

Table 3-1 summarizes the requirements for those individuals who should receive Radiological Worker Training.

At the WVDP: Personnel who have the likelihood to exceed, in one calendar year, any of the following radiation exposures, shall be radiological worker qualified and shall be assigned permanent dosimetry per Article 511:

1. One hundred (100) mrem effective dose;

2. Five (5) rem equivalent dose to the skin or to any extremity;

3. One and a half (1.5) rem equivalent dose to the lens of the eye.

631 General Provisions

1. Each individual shall demonstrate knowledge of the radiation safety training topics established in Article 613.1, commensurate with the hazards in the area and required controls, by successful completion of an examination and appropriate performance demonstrations prior to being permitted unescorted access to radiological areas and prior to performing unescorted assignments as a radiological worker [see 835.901(b)]. Radiological Worker Training should include the DOE's core course training materials (DOE-HDBK-1130-2008), as applicable, and should be expanded to include site-specific information.

2. Workers may challenge DOE's Radiological Worker I or II core knowledge requirements by passing a comprehensive examination. If unsuccessful in one attempt, the entire standardized core Radiological Worker I or II Training should be completed. Challenges should not apply to the site-specific portions.

3. Radiological Worker I Training is not a prerequisite for Radiological Worker II training.

4. Radiological Worker II Training includes all of the requirements of Radiological Worker I Training and expands on the topic of hands-on work with radioactive materials. Radiological Worker II Training prepares the worker to deal with higher levels of radiation and radioactive contamination.

5. Individuals with current Radiological Worker I Training may be upgraded to allow unescorted access to other areas by completing only the additional training provided in Radiological Worker II Training.

6. In the alternate year when training is not performed, refresher training should be completed.

7. If an escort is used in lieu of training, then the escort shall have completed the level of training required for the areas to be entered and the work to be performed and shall ensure that the escorted individual complies with the radiation protection program [see 835.901(d)].

8. **At the WVDP:** Radiological Worker qualification shall require:

   A. Satisfactory completion of the radiological worker qualification training program.

   B. No precluding radiological work restrictions that may prevent the employee from performing assigned tasks.

   C. Documentation of previous radiation exposure history on file.

   D. Bioassay, *In Vivo* count (whole body) and, if necessary, *In Vitro* urinalysis, baseline completed depending upon classification.

   E. Inclusion on the periodic bioassay roster according to qualification.

9. **At the WVDP:** Dosimetry badges shall be revoked when radiological worker requalification training or bioassay requirements described above have not been completed. If the worker completes the radiological worker requalification training course within three calendar months of expiration of the previous qualification, then the dosimetry badge will be returned. Otherwise, the worker must complete the original radiological worker qualification training course to receive their dosimeter badge.

10. **At the WVDP:** Radiological Workers may require additional training to enhance their overall performance and skills per Part 5 of this Chapter. Examples of these additional courses may include specialized training for management, technical support personnel, planners, Radiation Safety personnel, radiographers, emergency response personnel, and specialized radiological workers.

632 Radiological Worker I

1. Site-specific Radiological Worker I Training, including High/Very High Radiation Area Training (Article 632.3), should encompass at a minimum the following practical factors:

   A. Entering and exiting simulated radiological buffer areas and radiation areas (and high radiation areas when such training is included)

   B. Performance of frisking for personnel contamination, as applicable

   C. Verification of instrument response and source check

   D. Proper response to alarm situations

2. Course length will vary dependent upon the amount of site-specific material.

3. Unescorted worker access to high and very high radiation areas may be permitted upon successful completion of Radiological Worker I Training and High/Very High Radiation Area Training. Additional training (RWII) is required to enter contamination, high contamination, or airborne radioactivity areas unescorted, and soil contamination areas during activities that will disturb the soil.

4. **At the WVDP:** The final written examination for Radiological Worker I Qualification will contain a uniform sampling of all areas addressed above. To satisfactorily complete the examination a minimum score of 80% is required. The trainee must review the questions missed on the examination with a qualified instructor and sign a statement that he/she understands the missed questions.

5. **At the WVDP:** Annually, qualified radiological workers shall undergo either refresher training or retraining (see Article 613.4) and will demonstrate that they retained the required knowledge, understanding, and practical abilities necessary to retain their radiological worker qualification.

6. **At the WVDP:** Female employees shall be instructed on the Department of Energy and the National Council on Radiation Protection and Measurement's recommendations to keep radiation exposure to an embryo/fetus to the very lowest practicable level during the entire gestation period. This instruction shall be provided in the General Employee Radiological Training (GERT) portion of the WVDP General Employee Training (GET).

633 Radiological Worker II

1. Site-specific Radiological Worker II Training should encompass at a minimum the following practical factors:

   A. Donning of protective clothing, if applicable
   B. Entering a simulated radiological buffer area, contamination area and high radiation area to perform a task, if applicable
   C. Proper response to simulated abnormal situations
   D. Proper response to simulated alarms or faulty radiological control equipment
   E. Removing protective clothing and equipment and subsequently exiting the simulated area, if applicable
   F. Performance of frisking for personnel contamination, if applicable
   G. Verification of instrument response and source check
   H. **At the WVDP:** The ability to read the commonly used supplemental dosimeters;

2. Course length will vary dependent upon the amount of site-specific material.

3. **At the WVDP:** The written examination shall cover the training elements for Radiological Worker II with the practical examination consisting of the individual satisfactorily demonstrating each of the applicable practical factors contained above.

634 Specialized Radiological Worker Training

1. Specialized Radiological Worker Training should be completed for non-routine operations or work in areas with changing radiological conditions. This training is in addition to Radiological Worker I or II Training and should be provided to personnel planning, preparing, and performing jobs that have the potential for significant radiological consequences. Such jobs may involve special containment devices, the use of mockups, and ALARA considerations. In some cases, dependent upon site-specific criteria, pre-job briefings provide an acceptable alternative to Specialized Radiological Worker Training. The site-specific radiological control manual should establish the appropriate criteria that require Specialized Radiological Worker Training.

2. Based on the information cited above and requirements of 10 CFR 835, institution of the Radiological Worker I and II and specialized radiological worker training programs is sufficient to satisfy the job-specific training requirement of 10 CFR 835.902. The Department recognizes that other training provided in the workplace, including mock-up training for specific jobs, trade or craft specific training, laboratory safety training, and pre-job briefings, may include specific instructions regarding radiological controls. While the Department continues to encourage comprehensive training of the work force, documentation of these types of training is not required to satisfy the requirements of 10 CFR 835.902. The extent to which documentation of additional training is required to satisfy other provisions of 10 CFR 835 should be prescribed in the documented radiation protection program developed by the operating entity and approved by the Department.

PART 4 Radiological Control Technician and RCT Supervisor Qualification

641 General Provisions

Training and qualification of radiological control technicians (RCTs) and their immediate supervisors should address routine operations and also focus on recognizing and handling situations in both normal and changing radiological conditions. Newly qualified technicians and those still in training should be given the opportunity to work with qualified, experienced technicians to foster development.

1. **At the WVDP:** RCTs shall meet all requirements for training and qualifications as set forth in DOE-HDBK-1122-99. Approval of position qualification will be the responsibility of the Radiation Safety Manager. Position qualification will be made only after assuring that all the requirements of training, examinations, and work performance have been satisfied. By position qualification, Radiation Safety organization management will ensure that the individual is capable of performing aspects of the tasks for which the qualification was given.

642 Radiological Control Technician

1. Because of the nature of their duties (e.g., monitoring the workplace, implementing administrative controls and entry controls), RCTs would generally be expected to have responsibility for implementing measures necessary for ensuring compliance with 10 CFR 835. Therefore, RCTs will generally be subject to the education, training, and skills requirements of 10 CFR 835.103. RCT training should include the standardized core course training materials, as applicable, which should be expanded to include site-specific information.

   A. **At the WVDP:** DOE-HDBK-1122-99 presents a description of the RCT training program. The WVDP shall comply with, and incorporate all requirements presented in DOE-HDBK-1122-99 into the RCT training program.

2. RCT candidates who have prerequisite knowledge, such as college credit, operational experience, or related qualifications, may satisfy individual sections of the standardized core course training requirements by passing comprehensive challenge examinations.

3. Entry-level prerequisites should be established to ensure that RCTs meet the standards for physical condition and education. At a minimum, these standards should include the following:

   A. High school education or equivalency

   B. Fundamentals of mathematics, physics, chemistry, and science

   C. Systems and fundamentals of process, operations, and maintenance

   D. Reading and comprehension level sufficient to follow procedures, write permits, prepare survey maps, write reports, and prepare shipping and transfer permits

   E. Ability to work in a support role, including communicating verbal instructions to others

   F. Physical requirements to handle personal protective equipment and other equipment and assist others in work locations, commensurate with assignment.

4. RCTs are encouraged to pursue registration by the National Registry of Radiation Protection Technologists (NRRPT).

5. Sites are encouraged to give credit toward completion of standardized core training requirements for NRRPT registration.

6. **At the WVDP:** The RCT is the field representative of the Radiation Safety organization per Article 141 and shall be technically competent to provide radiological support for work or operations in all radiological areas. These individuals are required to retain a satisfactory understanding, knowledge and ability in the programs implemented by the Radiation Safety organization.

7. **At the WVDP:** The RCT qualification standards contain the specific knowledge and performance requirements that an individual must meet to be task qualified for a particular position.

8. **At the WVDP:** The minimum passing grade for each of the written and oral examinations is 80 percent. The qualified radiological control technician shall demonstrate proficiency in the areas listed in DOE-HDBK-1122-99.

9. **At the WVDP:** The qualification standards are approved and maintained by the Radiation Safety Manager. Revision and updating of the qualification standards shall be done as required.

10. **At the WVDP:** While in training, RCTs may be assigned to perform specific functions once they have been trained for such functions. Responsibility for performance of these functions, and direct line supervision for controlling these activities, shall be assigned by the Radiation Safety Manager, through the appropriate Radiation Safety Supervisor.

11. **At the WVDP:** Lectures, seminars, and/or training exercises used as alternate delivery methods for radiological control technician training may be used.

12. **At the WVDP:** Signature requirements for completing training phases and disqualification procedures and policies shall be consistent with DOE-HDBK-1122-99.

643 Qualification Standards for Radiological Control Technicians

Qualification Standards define the requirements for demonstrating completion of training. Signatures on the forms in Qualification Standards provide documentation of satisfactory proficiency.

1. The Qualification Standards from the standardized core course should be supplemented to include site-specific elements.

   A. **At the WVDP:** The qualification process shall include those items listed in DOE-HDBK-1122-99 and are tracked via the Training Requirements Validation Checklist (TRVC) system.

2. Qualification Standards for the radiological control technician position should include on-the-job training to provide hands-on experience directly applicable to the job.

   A. **At the WVDP:** Job performance measures shall be used to assess the trainee's ability to perform identified core and facility specific tasks.

3. **At the WVDP:** Trainees are evaluated on a satisfactory/unsatisfactory basis for each on-the-job-training task. Trainees should be given sufficient practice in performing the task before an evaluation is conducted. Any practical training completed with less than 100 percent proficiency on critical steps constitutes a failure. Failure of any task will require remedial action, which may include a repeat demonstration of the task by an on-the-job trainer / evaluator or allowing the trainee to perform the task with direct supervision.

644 Oral Examination Boards

The oral examination board provides an opportunity to identify areas of strength and weakness related to performance of radiological control technician duties and supervisor functions. The oral examination board also provides the opportunity to identify additional training needs to enhance radiological control technician and supervisor training programs.

1. The radiological control manager should consider using an oral examination board to determine the initial qualification and requalification of candidates for RCT and supervisor positions.

   A. **At the WVDP:** An oral examination board shall be performed upon completion of the Radiological Control Technician training, per DOE-HDBK-1122-99.

2. The radiological control manager should designate the board members and appoint a chairperson.

3. The board constituted to evaluate RCT qualification should be composed of at least three persons to include an RCT supervisor, radiological control staff, and line management operations department supervisors and staff personnel, as applicable. RCT instructors may participate as non-voting members.

4. The board should assess the candidate's response to normal and emergency situations. Questions should be of the type that is not normally covered in a written examination.

5. The board constituted to evaluate RCT supervisor qualification should not include peers or subordinates as voting members.

645 Continuing Training

1. Following initial qualification, the RCT should begin a 2-year cycle of continuing training required for requalification.

   A. **At the WVDP:** DOE-HDBK-1122-99 presents a description of the radiological control technician continuing training program. The WVDP shall comply and incorporate all requirements presented in DOE-HDBK-1122-99 into the radiological control technician continuing training program.

   B. **At the WVDP:** Continuing training should serve as the basis for requalification. Biennial requalification shall encompass a broad cross section of academic learning objectives, site-specific, and department-wide changes in requirements, lessons learned from operations and maintenance experience, and specific tasks.

2. Every requalification should include completion of practical training and a comprehensive written examination. A final oral examination board is encouraged.

   A. **At the WVDP:** A comprehensive written examination and oral examination board are required at the completion of the biennial requalification cycle. Passing criteria shall be the same as initial academic and facility specific on-the-job training. Students should demonstrate satisfactory performance of all tasks identified as critical or "over train" tasks approximately every two years.

3. Continuing training should provide continued improvement in the knowledge and skills of the RCT.

4. Continuing training should include site-specific and DOE-wide changes in requirements and updates of lessons learned from operating experience and industry events.

5. Continuing training should include written examinations as applicable, demonstrations of proficiency controlled by qualification standards, and oral examinations as needed to ensure understanding of the topic.

6. Infrequently performed tasks, such as those for emergency response, may require annual training. Other tasks may require training prior to initiation.

646 Radiological Control Technician Supervisors

1. Because of the nature of their duties, RCT supervisors would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103. Training and education standards for RCT supervisors should be consistent with DOE-STD-1107-2007, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.

2. RCT supervisors should have supervisory and leadership capabilities to direct the work of technicians; effectively interact with crafts, line supervisors, professional staff, and other managers; and be able to respond and direct others in emergency and abnormal situations.

3. RCT supervisors' knowledge of facility radiological control hazards, programs, and procedures should be reassessed every 2 years. DOE encourages the use of comprehensive oral examination boards in accordance with Article 643.

4. Oral examination boards should focus on the ability to analyze situations and supervise subordinates. The RCT supervisor's depth of knowledge should exceed that expected of an RCT.

5. **At the WVDP:** Radiation Safety Supervisors are required to retain satisfactory understanding, knowledge, and ability in all programs implemented by the Radiation Safety organization. Supervisors must continue to maintain DOE RCT qualification while in the position.

647 Subcontracted Radiological Control Technicians

1. Because their responsibilities closely parallel those of in-house RCTs, subcontracted RCTs would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should have the same knowledge and qualifications required of facility technicians performing the same duties. To obviate the need for full training as an RCT, the training and qualification program should include the following:

   A. Review of resumes to identify technicians with experience in jobs similar to those for which they will be employed

   B. Written examination and oral evaluation to verify appropriate knowledge level

   C. Identification of the duties technicians will be authorized to perform

   D. Training in facility procedures and equipment associated with the authorized duties

   E. Training on site-specific information, as applicable

   F. Observation of on-the-job performances by the radiological control technician Supervisor.

2. Subcontracted technicians who work at the facility for extended time periods (more than 6 months) should receive continuing training commensurate with their assigned duties, as applicable to the contract agreement. Completion of an oral examination in accordance with Article 643 is encouraged.

PART 5 Other Radiological Training

651 Management Training

1. Training and education standards for line managers of radiological control programs (or elements of those programs) should be consistent with DOE-STD-1107-2007, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.

2. Line managers (DOE and contractors) who manage, supervise, or provide oversight of radiological control programs would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should be trained in the principles of this Standard. DOE has sponsored development of a course appropriate for these individuals. This course is, Radiological Worker Training, Appendix A, Radiological Control Training for Supervisors DOE-HDBK-1130-2008 Appendix A.

3. Such training should be based on DOE's core course training materials supplemented by site-specific procedures and be completed by new personnel prior to formally assuming line supervision and management responsibilities. This training should include the following:

   A. Guidance on handling such personnel interactions

   B. Emphasis on being factual

   C. Fundamentals of communicating risks

   D. Importance of keeping management informed.

4. Incumbents should participate in continuing training. The continuing training should emphasize self-assessment and external evaluations including performance indicators, root causes, and lessons learned based on operational experience.

652 Technical Support Personnel

Appropriate technical support personnel (engineers, schedulers, procedure writers) may be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should be trained in the ALARA fundamentals and dose reduction techniques. They should also participate in selected portions of job-specific and specialized training, particularly in situations using mock-ups. Technical support personnel should receive training consistent with DOE-HDBK-1110-2008, ALARA Training for Technical Support Personnel.

653 Planners

Planners who develop detailed work plans involving or associated with radioactivity or radioactive materials should have Radiological Worker Training to the level required by the workers using the work plans. It is recommended that planners have Radiological Worker II training. Planners would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103. Planners should receive training consistent with DOE-HDBK-1110-2008, ALARA Training for Technical Support Personnel.

654 Radiological Control Personnel

1. Radiological Control senior staff (see Article 143) and management would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should have:

   A. A combination of education and experience commensurate with their job responsibilities

B. Continuing training based on an assessment of job responsibilities to maintain and enhance proficiency

C. Continuing training to remain cognizant of changes to the facility, operating experience, procedures, regulations, and quality assurance requirements.

2. Radiological support personnel may include but are not limited to: dosimetry technicians; instrument technicians; medical personnel; records clerks; whole body counter technicians; and laboratory personnel.

3. Radiological support personnel would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should have:

A. Applicable training on standardized core course topics from Radiological Worker I and II and Radiological Control Technician Training and additional job-specific topics

B. Training appropriate to the tasks to be performed

C. Continuing training to provide continued improvement in knowledge and skills.

4. Training and education standards for radiological control senior staff and support personnel should be consistent with DOE STD-1107-2007, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.

5. DOE encourages certification and involvement with professional industry organizations.

655 Radiographers and Radiation Generating Device Operators

1. Radiographers would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should have training in accordance with 10 CFR 34.31.

2. Radiation generating device operators would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should have training appropriate for the radiation source involved and commensurate with the level described in 10 CFR 34.31.

3. DOE has sponsored development of a course appropriate for operators of x-ray devices. This course is, Radiological Worker Training, Appendix B, Radiological Safety Training for Radiation-Producing (X-Ray) Devices, DOE-HDBK-1130-2008 Appendix B.

656 Emergency Response Personnel

Provisions should be in place to accommodate rapid site and radiological area access by on-site and off-site emergency workers such as firefighters, medical personnel, and security personnel.

1. Emergency response personnel, from both on-site and off-site, may be required to work in radiological areas.

2. Emergency response personnel should receive special radiological worker training commensurate with the situations they are likely to encounter. Any individual assigned to perform emergency actions that may result in a dose exceeding the occupational dose limits shall receive Radiological Worker or equivalent training [see 835.1302(c)].

3. Such training should be based on DOE's Radiological Worker core course and site-specific training materials.

4. If such workers are not trained, trained escorts should be assigned.

5. Training should make it clear that lifesaving has priority over radiological controls.

6. Records of this training should be maintained.

PART 6 Training For Special Applications

661 Plutonium Facilities

The content of DOE-HDBK-1145-2008, Radiological Safety Training for Plutonium Facilities, should be considered in addition to DOE's core training materials at plutonium facilities.

662 Uranium Facilities

The content of DOE-HDBK-1113-2008, Radiological Safety Training for Uranium Facilities, should be considered in addition to DOE's core training materials at uranium facilities.

663 Tritium Facilities

The content of the training appendix to DOE-HDBK-1129-2008, Tritium Handling and Safe Storage, should be considered in addition to DOE's core training material at tritium facilities.

664 Accelerator Facilities

The content of DOE-HDBK-1108-2002, Radiological Safety Training for Accelerator Facilities, should be considered in addition to DOE's core training material at accelerator facilities.

665 Radiological Contamination Control for Laboratory Research

DOE has sponsored development of a course appropriate for individuals who participate in laboratory research using radioactive materials. This course is, Radiological Worker Training, Appendix C, Radiological Contamination Control for Laboratory Research, DOE-HDBK-1130-2008 Appendix C.

CHAPTER 7 RADIOLOGICAL CONTROL RECORDS

TABLE OF CONTENTS

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PART 1 General Provisions

711 Purpose

This chapter prescribes practices for preparing and retaining radiological control records. The work force and management are required to use records to document radiological safety afforded to individuals on-site. Records of radiological control programs may be required to support worker health studies and future disputes or claims. Therefore, these records should be high quality, readily retrievable, and managed for the prescribed retention period. Consideration should be given to cross-referencing related records to aid retrievability. Records should be handled such that personal privacy is protected.

712 Records Management Program

1. A radiological records management program should be established. This program should ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable), and disposition. The records management program shall be sufficient to ensure that records are maintained as necessary to document compliance with 10 CFR 835 [see 835.701(a)] and should include records of the following:

   A. Radiological Control Policy Statements
   B. Radiological Control Procedures
   C. Individual Radiological Doses
   D. Internal and External Dosimetry Policies and Procedures (including Bases Documents)
   E. Personnel Training (course records and individual records)
   F. ALARA Program Implementation
   G. Radiological Instrumentation Test, Maintenance, and Calibration
   H. Radiological Surveys
   I. Area Monitoring Dosimetry Results
   J. Radiological Work Permits
   K. Radiological Performance Indicators and Assessments
   L. Radiological Safety Analysis and Evaluation Reports
   M. Quality assurance measures
   N. Radiological Incident and Occurrence Reports (and Critique Reports, if applicable)
   O. Sealed radioactive source accountability and control
   P. Release of material to controlled areas
   Q. Reports of loss of radioactive material.

2. Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service. Records of results should reside in the custody of the originating contract organization.

3. Detailed information concerning an individual's exposure shall be made available to that individual, upon request. An individual's exposure information may be provided to others consistent with the Privacy Act of 1974, which contains requirements to protect the privacy of individual records [see 835.702(f) and 801(d)].

4. **At the WVDP:** The radiological record-keeping and reporting requirements are be implemented and maintained in WVDP-293, "WVDP Radiological Protection Record-Keeping and Reporting Program Manual."

   A. **At the WVDP:** Records management is responsible for maintaining all training records that are generated in accordance with Article 725.

   B. **At the WVDP:** Regulatory Affairs is responsible for maintaining all environmental surveillance and measurement records.

C. **At the WVDP:** Waste Management is responsible for maintaining all radioactive waste management records.

D. **At the WVDP:** Employee Health Services is responsible for maintaining all employee medical records that are generated in accordance with Article 724.

5. **At the WVDP:** The WVDP should follow the guidance contained in DOE G 441.1-1C," Radiation Protection Programs Guide."

713 Recordkeeping Standards

1. Radiological control records should be accurate and legible. The records should include the following:

A. Identification of the facility, specific location, function, and process

B. Signature or other identifying code of the preparer and date

C. Legible entries in ink

D. Corrections identified by a single line-out, initialed and dated

E. Supervisory signature to ensure review and proper completion of forms.

At the WVDP: No supervisory signature will be obtained on form WV-1106, "Unrestricted Release Tag," prior to the release of an item or items being surveyed per radiological control procedures. Radiological control technicians shall be trained on how to fill out and complete form WV-1106 [*Article 113*].

2. A file of names, signatures, and initials for future identification of the individual who signed or initialed a record should be maintained, as needed, with the record or by the radiological control organization.

A. **At the WVDP:** The Radiation Safety organization maintains a file of names, signatures, and initials for Radiation Safety personnel. All site personnel adhere to the quality assurance requirements in WVDP-002 for creating legible, accurate, and completed records *[Article 113]*.

3. Radiological control records should not include:

A. Opaque substances for corrections

B. Shorthand or other non-standardized terms.

4. Similar procedural standards should be established for computerized records.

5. Unless otherwise specified, radiological control records shall use the special units of curie, roentgen, rad, and rem, including multiples of these units, or other conventional units such as dpm, dpm/100 cm^2 [see 835.4]. Use of the international system of units (becquerel, gray, and sievert) should be limited to calculational, scientific, or reference purposes. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv), may be provided parenthetically for reference with scientific standards.

PART 2 Employee Records

721 Employment History

1. For each radiological worker whose occupational exposure is monitored in accordance with Article 511.1 or 521.1, efforts shall be made to obtain records of prior years' occupational doses. If formal records of previous occupational doses cannot be obtained, a written estimate signed by the individual may be accepted [see 835.702(e)]. Where practical, the association between the radiation dose and job function should be preserved for trending purposes and future worker health studies. The following information should be maintained:

   A. Previous work history detailing radiological work assignments, to the extent practical, and yearly occupational doses at other DOE and non-DOE facilities.

   B. Nuclear Regulatory Commission Form 4 or equivalent that documents previous occupational radiation doses.

   C. Ongoing work history documenting job classification and radiation doses; the facility and occupational codes defined in DOE O 231.1A, Environment Safety and Health Reporting, should be used for this process.

   D. DOE standardized forms to document previous and ongoing radiation doses.

722 Personnel Radiological Records

1. Individual monitoring records shall be maintained to demonstrate compliance with the regulatory limits [see 835.701(a)].

   A. Records of doses received by all individuals for whom individual monitoring was performed as required by Article 511.1 or 521.1, including records of zero dose, shall be maintained [see 835.702(a)].

   B. These records shall be sufficient to evaluate compliance with all applicable dose limits and monitoring and reporting requirements [see 835.702(c)(1) & (2)].

   C. **At the WVDP:** Individual dose records are normally retained 75 years and will be retained as directed to support future epidemiological studies. Dose assessment calculations and methods are retained as required by DOE O 243.1. Records retained and reported shall be sufficient to support recalculation of doses at a later date, and shall be in accordance with the requirements of ANSI N13.6.

   D. **At the WVDP:** A Special Dose Evaluation (SDE) form is used by dosimetry to estimate the dose received by an individual (external and/or internal) when the dose cannot be determined by normal means. The SDE becomes part of the individual's dose record.

      Special studies, evaluations, and interpretations in support of such activities as exposure questionnaire reviews, evaluation of nonuniform exposures to radiation, investigations of incidents, and internal dose assessments are retained. In those cases where recordable doses are determined to have occurred, the results of these evaluations, consisting of a summary report that describes the data, explains the techniques used to evaluate the data, and lists the doses to be assigned, shall be maintained.

   E. **At the WVDP:** Individual occupational internal and external dose records used to assess individual doses shall be generated and maintained sufficient to provide appropriate reports to the employee, management, and those required by DOE O 231.1A.

2. Radiation dose records shall contain information sufficient to identify each person, including social security, employee number, or other unique identifier [see 835.702(c)(2)].

3. Procedures, data, and supporting information needed to reconfirm an individual's dose at a later date shall be maintained [see 835.702(g)].

4. External dose records shall include applicable extremity, skin, lens of the eye, and whole body dose monitoring results [see 835.702(c)(3)]. These doses are usually measured with personnel dosimeters, but records may include:

   A. Evaluations resulting from anomalous dose results such as unexpected high or low doses

   B. Dose evaluations from lost or damaged dosimeters, or for unmonitored workers

   C. Evaluations of non-uniform radiation doses.

5. Internal dose records shall include committed effective dose [see 835.702(c)(4)(i)], committed equivalent doses to the affected organs and tissues [see 835.702(c)(4)(ii)], and identity of radionuclides [see 835.702(c)(4)(iii)]. The supporting information typically includes the following:

   A. Applicable whole body and lung counting results (including chest wall thickness measurements where applicable)

   B. Applicable urine, fecal and specimen analysis results, including estimated intake

   C. Dose assessment, as required.

6. Records of the summation of external equivalent dose to the whole body and committed equivalent dose to any organ receiving a reportable dose shall be maintained for the individual receiving such dose [see 835.702(c)(5)(ii)].

7. The total effective dose received by each individual monitored in accordance with Article 511.1 or 521.1 shall be maintained for each year the individual is monitored [see 835.702(c)(5)(i)].

8. The equivalent dose to the embryo/fetus of a declared pregnant worker shall be maintained [see 835.702(c)(6)] and should be maintained with the occupational dose records for that worker.

9. Individual dose records shall include the cumulative total effective dose [see 835.702(c)(5)(iii)].

10. Efforts shall be made to obtain records of prior years' doses for each radiological worker monitored in accordance with Article 521 or 522 [see 835.702(e)]. If an individual's previous employer is not responsive to initial efforts to obtain these records, at least two additional attempts should be made. Records of lifetime occupational dose should be maintained with the individual's occupational dose records. Some radiological workers, such as Defense Nuclear Facilities Safety Board and DOE Headquarters staff members, may have site access but not be expected to exceed 100 mrem in a year at the site. Maintenance of lifetime dose records for these individuals is not expected.

11. Records of authorization to exceed administrative control levels should be retained.

12. Emergency doses and planned special exposures [see 835.204 & 1302] shall be accounted for separately, but should be maintained with the individual's occupational dose records.

13. Records of non-uniform dose to the skin need not be retained in an individual's dose records if the dose is less than 2 percent of the limit for the skin in Table 2-1 [see 835.702(b)] (see Article 723 for requirements for records of radiological incidents and occurrences).

14. Records of internal dose (committed effective dose or committed equivalent dose) are not required if the dose is less than 0.01 rem (0.1 mSv). The bioassay or air monitoring result used to estimate the dose shall be maintained. The unrecorded internal dose estimated for any individual in a year shall not exceed the applicable monitoring threshold.

723 Other Personnel Radiological Records

1. The complete records of radiological incidents and occurrences involving personnel dose should be retained in, or cross-referenced to, the individual's dose records. Records related to doses exceeding the Table 2-1 limits including authorized emergency doses and planned special exposures and other, non-authorized doses exceeding the limits, shall be maintained [see 835.1301(b)].

2. Records of employee radiological safety concerns that have been formally investigated and documented should be maintained.

3. Records of the formal written declaration of pregnancy, including the estimated conception date, and revocations of declarations of pregnancy shall be maintained [see 835.704(d)]. Records indicating that the pregnancy has concluded (therefore, the conditions of Article 215 do not apply) should also be maintained.

724 Medical Records

1. Pre-employment medical records, if available, and reports of periodic medical examinations should be maintained.

2. Physical examination reports and fit testing results for respirator use should be maintained for respirator users.

3. Medical evaluations and treatment performed in support of the radiological control program should be documented.

725 Radiological Training and Qualification Records

1. Records of training and qualification in radiological control are maintained to demonstrate that an individual received appropriate information to perform the work assignment in a safe manner. Qualification standard records are retained for on-the-job and practical factor training as well as for formal classroom training.

   A. **At the WVDP:** Training records of general employees, radiological workers, RCTs, and visitors shall be retained to document the level of understanding and proficiency of personnel who work with radioactive materials. Certification of successful completion of training programs and performance records should also be retained.

2. Formal records or summary reports of training and qualification should be readily available to first-line supervision and management of involved personnel to aid in making work assignments.

3. Personnel training records shall be controlled and retained [see 835.704(a)]. At a minimum, these records should include the following:

   A. Course title

B. Attendance records with instructor's name

C. Employee's name and identification number

D. Date of training

E. Identification of the examination or evaluation form, including sufficient data to identify which test each individual completed

F. Verification document or record confirming satisfaction of the training requirement

G. Documentation related to exceptions for training requirements and extensions of qualification

H. Quizzes, tests, responses and acknowledgments of training, with the date and signature of the individual trained

I. Special instructions to females, their supervisors, and coworkers concerning prenatal radiation dose, acknowledged by the worker's signature.

4. Records shall be retained for the following types of radiation safety training [see 835.704(a)]:

A. General employee radiological training

B. Radiological worker training

C. Periodic training, as appropriate

D. Members of the public training for unescorted access.

Records should be retained for the following types of radiation safety training:

A. Instructor training

B. Training of other radiological control personnel

C. Respiratory protection training

D. Qualifications for special tests or operations

E. Orientation of members of the public

F. Training of emergency response personnel.

5. Records shall be maintained as necessary to demonstrate that individuals who are responsible for the development and implementation of measures necessary to ensure compliance with 10 CFR 835 have the appropriate education, training, and skills to execute these responsibilities [see 835.103 and 835.701(a)]. These records should include records of the training provided in accordance with Parts 4 and 5 of Chapter 6 of this Standard.

6. The following instructional materials should be maintained:

A. Course name, with revision and approval date.

B. Instructor's manuals, course content, or lesson plans containing topical outlines.

C. Video and audio instructional materials, including the dates and lessons for which they were used.

D. Official handouts or other materials retained with the master copy of the course.

E. Job-specific training documents, such as instrument use, radiological procedures, radiological work permit special training requirements, pre-job briefings, and mock-up training.

PART 3 [Reserved]

PART 4 Radiological Control Procedures

741 Policies, Procedures, and Radiological Work Permits

Records of the radiological control program should consist of policy statements, procedures, work authorizations, and supporting data. The records should be maintained in a manner that will allow correlation with the corresponding support information. For example, procedures for performing radiation surveys should be identifiable with the survey results. Completed radiological work permits should be maintained.

742 ALARA Program Records

Records of actions taken to maintain occupational exposures ALARA shall be maintained [see 835.701(a)]. These records shall include facility design and control measures [see 835.704(b)] and should include:

A. ALARA plans and goals

1. **At the WVDP:** ALARA plans and goals are maintained and updated through internal correspondence.

B. The minutes of ALARA committees and other committees where radiological safety issues are formally discussed

C. Records of pre-job briefings and post-job evaluations

D. Records of temporary shield and portable ventilation installation and removal.

743 Quality Assurance Records

Records of quality assurance reviews and audits developed for radiological control functions shall be retained to ensure that sufficient records are specified, prepared, reviewed, approved, and maintained to accurately reflect completed work [see 835.704(c)]. DOE O 414.1C, Quality Assurance and 10 CFR 830.120 provide additional information regarding quality assurance records. Quality assurance records should include:

A. Assessment checklists

B. Assessment methods

C. Assessment results

D. Assignment of corrective actions

E. Completion and verification of corrective actions.

PART 5 Radiological Monitoring

751 Area Monitoring Records

1. Radiological control programs require the performance of radiation, airborne radioactivity, and contamination monitoring to determine existing conditions in a given location. Databases, forms or maps with sufficient detail to permit identification of original survey and sampling locations should be maintained. Radiological monitoring results should be recorded on appropriate standard forms and include the following common elements:

   A. Date, time, and purpose of the survey

   B. General and specific location of the survey

   C. Name and signature of the surveyor and analyst

   D. Pertinent information needed to interpret the survey results

   E. Reference to a specific radiological work permit if the survey is performed to support the permit.

2. Records shall be maintained to document:

   A. Results of monitoring and surveys for radiation and radioactive materials [see 835.703(a)]

   B. Results of monitoring and calculations used to determine individual occupational doses [see 835.703(b)]

   C. Results of surveys for release of materials from radiological areas [see 835.703(c)]

   D. Results of sealed radioactive source leak tests and inventories [see 835.704(f)]

   E. Results of surveys of radioactive material packages received from transportation [see 835.405 and 701(a)]

   F. Changes in monitoring equipment, techniques, and procedures [see 835.704(e)].

3. **At the WVDP:** Records shall be kept to document the appropriateness, quality, and accuracy of monitoring methods, techniques, and procedures in use during any given period pursuant to ANSI N13.6, Section 6.

4. **At the WVDP:** Records that establish the conditions under which individuals were exposed, such as facility radiological conditions (as generated by the monitoring programs) and surveys for the release of personal property and the workplace surfaces, shall be kept to provide a chronological, historical record pursuant to ANSI N13.6, Section 5.

752 Radiation Monitoring

1. In addition to the elements provided in Article 751, records of radiation monitoring should include at a minimum, the following information:

   A. Instrument model and serial number

   B. Results of the measurements of area dose rates

C. Locations of hot spots and other radiological hazards

D. Facility conditions existing during the survey that may have affected radiological conditions, as applicable.

753 Airborne Radioactivity Monitoring

1. In addition to the elements provided in Article 751, records of airborne radioactivity monitoring should include, at a minimum, the following information:

A. Model and serial number of the sampler or unique identifier of each sampler and laboratory counting instrument and appropriate supporting parameters including counting efficiency, counting time, and correction factors

B. Locations of fixed air samplers

C. Locations of portable air samplers used for a survey

D. Measured air concentrations

E. Supporting parameters, including collection efficiency, flow rate, duration of sampling, correction factors, and filter medium

F. Identification (e.g., names and/or employee numbers) of individuals in the area for whom DAC-hour exposure should be calculated.

754 Contamination Monitoring

1. In addition to the elements provided in Article 751, records of contamination monitoring should include, at a minimum, the following information:

A. Model and serial number of counting equipment, when direct-reading surveys are conducted

B. Contamination levels (using appropriate units) and whether the contamination was fixed or removable

Appropriate supporting parameters such as counting efficiency, counting time, correction factors, type of radiation

C. Location of areas found to contain hot particles or high concentrations of localized contamination

D. Follow-up survey results for decontamination processes, preferably cross-referenced to the original survey

755 Sealed Radioactive Source Leak Tests and Inventories

1. In addition to the elements provided in Article 751, records of sealed radioactive source leak tests should include, at a minimum, the following information:

A. Model and serial number of counting equipment

B. Contamination levels (using appropriate units) and type of radiation with appropriate supporting parameters such as counting efficiency, counting time correction factors

C. Corrective actions for leaking sources.

2. Records of accountable sealed radioactive source inventories shall include, at a minimum, the following information [see 835.704(f) and 835.1202(a)]:

A. The physical location of each accountable sealed radioactive source

B. Verification of the presence and adequacy of associated postings and labels

C. Verification of the adequacy of storage locations, containers, and devices.

PART 6 Instrumentation and Calibration Records

761 Calibration and Operational Checks

1. Calibration records for fixed, portable, and laboratory radiation measuring instruments and equipment and individual monitoring devices shall be maintained [see 835.703(d)]. These calibration records should include frequencies, method, dates, personnel, training, and traceability of calibration sources to National Institute of Standards and Technology or other acceptable standards.

2. Calibration and maintenance records shall be maintained for instruments and equipment used for monitoring [see 835.703d]. Calibration and maintenance records should be maintained for the following equipment:

   A. Portable survey instruments
   B. Bioassay measurement equipment
   C. Laboratory, counting room, and fixed radiation measuring equipment
   D. Process and effluent monitors and sampling equipment
   E. Radiation area monitors
   F. Portal monitors and other personnel contamination monitors
   G. Pocket and electronic dosimeters
   H. Air sampling equipment
   I. Tool and waste monitoring equipment
   J. Protective clothing and equipment monitors.

3. Documentation of instrument operational checks for documented surveys shall be maintained [see 835.701(a) & 835.401(b)(4)]. Such records should be maintained for a period not less than the calibration period of the instrument.

4. Maintenance results for each instrument and device shall be created and retained [see 835.703(d)]. Maintenance histories for each instrument and device should be created and include the nature of any defects and corrective actions taken.

762 Special Calibration Records

Records of additional tests and checks of instrumentation used in conjunction with a suspected overexposure, questionable indication, or unusual occurrence should be retained. In addition, records of special instrument calibrations and modifications made in accordance with Article 562.6 shall be retained [see 835.703(d)].

PART 7 Records Management

771 Media

A combination of media may be used for a comprehensive records system. All records should be stored in a manner that ensures their integrity, retrievability, and security and, unless otherwise specified, shall be retained until final disposition is authorized by DOE [see 835.701(b)].

772 Microfilm

Records may be microfilmed provided the resulting film copy is capable of producing a clear, legible copy after storage for the specified period. The following controls should be administered:

1. Verification that the resultant copy is legible Some radiological workers, such as Defense Nuclear Facilities Safety Board and DOE Headquarters' staff members, may have site access but not be expected to exceed 100 mrem in a year at the site. Maintenance of lifetime dose records for these individuals is not expected.

2. Confirmation that printed sides are copied

3. Periodic quality audits of the final filmed copy.

773 Computerization of Records

1. Records may be transferred to electronic storage media provided certain precautions are taken to ensure that the information is maintained in a retrievable configuration.

2. Controls for the use and handling of electronic storage media should include the following:

   A. A master index of documents on the electronic storage medium
   B. A program to ensure back-up and retrievability of information
   C. Quality control during data entry and analysis
   D. An index identifying software applications used in conjunction with the data
   E. Software validation and verification
   F. Periodic quality audits of software
   G. Prevention of unauthorized manipulation of data
   H. Assurance that previously stored information is retrievable and useable after system modifications.

774 Retention

1. 10 CFR 835 establishes requirements for retaining records. Upon cessation of activities that could result in the occupational exposure of individuals, all required records related to individual exposure monitoring shall be transferred to DOE [see 835.702(h)].

2. Once a record has been created, reviewed, and signed by appropriate supervision, the record is considered complete and should not be modified. Subsequent errors identified in a completed record may be corrected by creating a supplemental record that includes traceability for the correction.

775 Physical Protection of Records

1. Methods for protecting documents should include vaults, file rooms with fixed fire suppression, fire rated cabinets, duplicate storage, or combinations of these.

2. Storage arrangements should address physical damage that could be caused by temperature extremes, moisture, infestation, electromagnetic fields, excessive light, stacking, theft, and vandalism.

3. Records should, as a minimum, be protected from:

   A. Exposure to fire, equivalent to an Underwriters Laboratories, Inc., 1.5-hour, or greater, fire resistance rating

   B. Exposure to water damage caused by a 100-year flood

   C. Exposure to windstorm velocities of 100-year recurrence.

PART 8 Radiological Reporting

781 Reports to Individuals

1. Individuals who are monitored in accordance with Article 511.1 or 521.1 shall be provided an annual report of their dose [see 835.801(c)]. Upon request, an individual shall be provided detailed information concerning his or her exposure [see 835.801(d)].

2. Upon request, terminating employees shall be provided a report, as soon as data are available but not later than 90 days following the last day of employment. A written estimate, based upon available information, shall be provided upon termination, if requested [see 835.801(b)].

3. Reports of individual doses shall include the site or facility name, the individual's name and social security number, employee number, or other unique identification number, and all dose information required by Articles 722.4 - 722.9 [see 835.801(a)]. Reporting of lifetime occupational dose is suggested.

4. Reports of individual exposure to radiation or radioactive material required under DOE O 232.1 or as a result of a planned special exposure, emergency exposure, or accident should be submitted to DOE in accordance with applicable occurrence reporting requirements. Copies of the individual dose information contained in these reports shall be provided to the affected individual at a time not later than transmittal of the report to the Department [see 835.801(e)].

5. Monitoring results, including zero dose, should be reported to each member of the public monitored in accordance with Article 511 or 521 within 30 days and no later than 90 days after the end of the visit. This report may serve as the annual report to these individuals. However, if an individual visits a site or facility more than once in a year, then an annual report should be sent which sums the doses from all of the visits.

    A. **At the WVDP:** Visitors will indicate, prior to issuance of visitor dosimetry, if an unofficial report is desired immediately upon completion of visit.

    B. **At the WVDP:** Dose history requests from individuals and employers that comply with the Privacy Act (Title 5, U.S.C., Part 552a) will also be honored.

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DOE M 231.1-1A, Environment, Safety and Health Reporting Manual, provides reporting requirements for the Annual Radiation Dose Summary. This report includes internal and external radiation dose results for monitored DOE and DOE contractor employees, and for monitored members of the public.

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GLOSSARY

Terms from 10 CFR 835 are used consistent with their regulatory definition.

Terms defined in the Atomic Energy Act of 1954 or in 10 CFR part 820 and not defined in this part are used consistent with their meanings given in the Atomic Energy Act of 1954 or in 10 CFR part 820 [**10 CFR 835.2.(c)**].

abnormal situation: Unplanned event or condition that adversely affects, potentially affects, or indicates degradation in the safety, security, environmental, or health protection performance or operation of a facility.

Accountable sealed radioactive source means a sealed radioactive source having a half-life equal to or greater than 30 days and an isotopic activity equal to or greater than the corresponding value provided in appendix E of this part**.** [**10 CFR 835.2(a)**].

activation: Process of producing a radioactive material by bombardment with neutrons, protons, or other nuclear particles.

administrative control level: A numerical occupational dose constraint established at a level below the occupational dose limits provided in Chapter 2 to administratively control and help reduce individual and collective dose.

Airborne radioactive material or airborne radioactivity means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases. [**10 CFR 835.2(a)**].

Airborne radioactivity area means any area, accessible to individuals, where:

(1) The concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the derived air concentration (DAC) values listed in appendix A or appendix C of this part; or

(2) An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week. [**10 CFR 835.2(a)**].

ALARA means "As Low As is Reasonably Achievable," which is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits of this part as is reasonably achievable [**10 CFR 835.2(a)**].

ALARA Committee: Multi-disciplined forum that reviews and advises management on improving progress toward controlling radiation exposure and radiological releases.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose of 5 rems (0.05 sieverts (Sv)) (1 rem = 0.01 Sv) or a committed equivalent dose of 50 rems (0.5 Sv) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on International Commission on Radiological Protection Publication 68, Dose Coefficients for Intakes of Radionuclides by Workers, published July, 1994 (ISBN 0 08 042651 4). This document is available from Elsevier Science Inc., Tarrytown, NY. [**10 CFR 835.2(a)**].

assessment: Evaluation or appraisal of a process, program, or activity to estimate its acceptability.

Background radiation means radiation from:

(1) Naturally occurring radioactive materials which have not been technologically enhanced;
(2) Cosmic sources;
(3) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);

(4) Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and
(5) Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation [**10 CFR 835.2(a)**].

becquerel (Bq): The International System (SI) derived unit for radioactivity. One becquerel is equal to one nuclear decay or transformation per second.

bioassay: The determination of the kinds, quantities, or concentrations, and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis and evaluation of radioactive materials excreted or removed from the human body [see 835.2(a)].

calibration: The process of adjusting or determining either:

(1) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or

(2) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value [see 835.2(a)].

company-issued clothing: Clothing provided by the company for non-radiological purposes, such as work coveralls and shoes.

containment device: Barrier, such as a glovebag, glovebox, or tent, for inhibiting the release of radioactive material from a specific location.

Contamination area means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in appendix D of this part, but do not exceed 100 times those values. [**10 CFR 835.2(a)**].

continuing training: Training scheduled over a specified time, such as over a two-year period, for the purpose of maintaining and improving technical knowledge and skills.

continuous air monitor (CAM): Instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels. Also referred to as a real-time air monitor.

contractor senior site executive: The individual at a DOE contractor-operated facility or site who has final on-site corporate authority and is often called President, General Manager, Site Manager, or Director.

Controlled area means any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material [**10 CFR 835.2(a)**].

counseling: Advice, information exchange, and guidance provided to employees on radiologically related topics, such as dose perspectives; potential health effects from radiation exposure; skin contaminations; contaminated wounds; internally deposited radioactivity; pregnancy; and radiation exposure. This advice and guidance are normally provided by knowledgeable, senior professionals from the radiological control organization and other organizations, such as Medical, as appropriate.

critical mass: The smallest mass of fissionable material that will support a self-sustaining chain reaction under specified conditions.

critique: Meetings of personnel involved in or knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts.

Declared pregnant worker means a woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational dose limits to the embryo/fetus as provided in § 835.206. This declaration may be revoked, in writing, at any time by the declared pregnant worker [**10 CFR 835.2(a)**].

decontamination: Process of removing radioactive contamination from personnel, equipment, or areas.

Derived air concentration (DAC) means, for the radionuclides listed in appendix A of this part, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3). For the radionuclides listed in appendix C of this part, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite cloud of radioactive material. Except as noted in the footnotes to appendix A of this part, the values are based on dose coefficients from International Commission on Radiological Protection Publication 68, Dose Coefficients for Intakes of Radionuclides by Workers, published July, 1994 (ISBN 0 08 042651 4) and the associated ICRP computer program, The ICRP Database of Dose Coefficients: Workers and Members of the Public, (ISBN 0 08 043 8768). These materials are available from Elsevier Science Inc., Tarrytown, NY. [**10 CFR 835.2(a)**].

Derived air concentration-hour (DAC-hour) means the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to that radionuclide, in hours [**10 CFR 835.2(a)**].

direct contamination reading: The apparent surface contamination level, expressed in disintegrations per minute per 100 cm^2, resulting when an appropriate contamination probe or detector is placed in close proximity (e.g., ~1/4 inch) to the soil surface. Appropriate efficiency and geometry correction factors should be applied to such a reading.

disintegration per minute (dpm): The rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

Deterministic effects means effects due to radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation-induced opacities within the lens of the eye) [**10 CFR 835.2(a)**].

DOE activity means an activity taken for or by DOE in a DOE operation or facility that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and operations, possibly including an entire site or multiple DOE sites [see 10 CFR 835.2(a)].

DOELAP: Department of Energy Laboratory Accreditation Program for personnel dosimetry and bioassay programs.

Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

dose assessment: Process of determining radiation dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information, and pathway analysis.

embryo/fetus: Developing human organism from conception until birth. Same as unborn child.

Absorbed dose (D) means the average energy imparted by ionizing radiation to the matter in a volume element. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray) [**10 CFR 835.2(b)**].

Committed equivalent dose ($H_{T,50}$) means the equivalent dose calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed equivalent dose is expressed in units of rems (or Sv) [**10 CFR 835.2(b)**].

Committed effective dose (E_{50}) means the sum of the committed equivalent doses to various tissues or organs in the body ($H_{T,50}$), each multiplied by the appropriate tissue weighting factor (w_T)--that is, $E_{50} = \Sigma w_T H_{T,50} + w_{Remainder} H_{Remainder,50.}$ Where $w_{Remainder}$ is the tissue weighting factor assigned to the remainder organs and tissues and $H_{Remainder,50}$ is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rems (or Sv) **[10 CFR 835.2(b)]**.

Cumulative total effective dose means the sum of all total effective dose values recorded for an individual plus, for occupational exposures received before the implementation date of this amendment, the cumulative total effective dose equivalent (as defined in the November 4, 1998 amendment to this rule) values recorded for an individual, where available, for each year occupational dose was received, beginning January 1, 1989 [**10 CFR 835.2(b)**].

Dose is a general term for absorbed dose, equivalent dose, effective dose, committed equivalent dose , committed effective dose, or total effective dose as defined in this part [**10 CFR 835.2(b)**].

Effective dose (E) means the summation of the products of the equivalent dose received by specified tissues or organs of the body (H_T) and the appropriate tissue weighting factor (w_T)--that is, $E = \Sigma w_T H_T$. It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, equivalent dose to the whole body may be used as effective dose for external exposures. The effective dose is expressed in units of rems (or Sv) [**10 CFR 835.2(b)**].

Equivalent dose (H_T) means the product of average absorbed dose ($D_{T,R}$) in rad (or gray) in a tissue or organ (T) and a radiation (R) weighting factor (w_R). For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rems (or Sv) [**10 CFR 835.2(b)**].

External dose or exposure means that portion of the equivalent dose received from radiation sources outside the body (i.e., "external sources") [**10 CFR 835.2(b)**].

Extremity means hands and arms below the elbow or feet and legs below the knee [**10 CFR 835.2(b)**].

Internal dose or exposure means that portion of the equivalent dose received from radioactive material taken into the body (i.e., "internal sources"). [**10 CFR 835.2(b)**].

Radiation weighting factor (w_R) means the modifying factor used to calculate the equivalent dose from the average tissue or organ absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate radiation weighting factor. [**10 CFR 835.2(b)**].

Tissue weighting factor (w_T) means the fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The equivalent dose to tissue, (H_T), is multiplied by the appropriate tissue weighting factor to obtain the effective dose (E) contribution from that tissue [**10 CFR 835.2(b)**].

Total effective dose (TED) means the sum of the effective dose (for external exposures) and the committed effective dose. [**10 CFR 835.2(b)**].

Whole body means, for the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee [**10 CFR 835.2(b)**].

engineering controls: A special form of physical design feature in which components and systems, such as piping, containments, ventilation, filtration, or shielding, are used to reduce airborne radioactivity, radiation levels, and the spread of contamination.

entrance or access point: Any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use [see 835.2(a)].

facility: For the purpose of the DOE Radiological Control Standard, a facility includes systems, buildings, utilities, and related activities whose use is directed to a common purpose at a single location. Examples include: accelerators, storage areas, test loops, nuclear reactors, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, and accommodations for analytical examinations of components. Also includes: pipelines, ponds, impoundments, landfills and the like and motor vehicles, rolling stock, and aircraft.

filter integrity test: Test performed on High-Efficiency Particulate Air (HEPA) filters to identify any damage to the filter or leakage around the filter.

fixed contamination: Radioactive material that has been deposited onto a surface and cannot be readily removed by non-destructive means, such as casual contact, wiping, brushing, or laundering. Fixed contamination does not include radioactive material that is present in a matrix, such as soil or cement, or radioactive material that has been induced in a material through activation processes.

frisk or frisking: Process of surveying personnel for contamination. Frisking can be performed with hand-held survey instruments or automated monitoring devices.

General employee means an individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or an individual who performs work for or in conjunction with DOE or utilizes DOE facilities [**10 CFR 835.2(a)**].

gestation period: The time from conception to birth, approximately 9 months.

gray (Gy): SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rads).

high-efficiency particulate air (HEPA) filter: Throwaway extended pleated medium dry-type filter with 1) a rigid casing enclosing the full depth of the pleats, 2) a minimum particle removal efficiency of 99.97 percent for thermally generated monodisperse di-octyl phthalate smoke particles with a diameter of 0.3 micrometer, and 3) a maximum pressure drop of 1.0 inch w.g. when clean and operated at its rated airflow capacity.

High contamination area means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in appendix D of this part [**10 CFR 835.2(a)**].

High radiation area means any area, accessible to individuals, in which radiation levels could result in an individual receiving an equivalent dose to the whole body in excess of 0.1 rems (0.001 Sv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates [**10 CFR 835.2(a)**].

hot particle: Fuel, activated corrosion product, or other particles of small size that have a high specific activity as a result of nuclear fission or neutron activation. When in direct contact with the skin, hot particles are capable of producing a equivalent dose to the skin of 100 millirem or more in one hour to a localized area.

hot spot: Localized source of radiation or radioactive material normally within facility piping or equipment. The radiation levels of hot spots exceed the general area radiation level by more than a factor of 5 and are greater than 100 millirem (1 mSv) per hour on contact.

Individual means any human being [**10 CFR 835.2(a)**].

infrequent or first-time activities: Radiological work activities or operations that require special management attention and consideration of new or novel radiological controls. The designation of infrequent or first-time activities is specifically applicable to facilities that conduct routine and recurring process operations, and is not applicable to facilities that routinely conduct first-time activities, such as experimental or research facilities.

irradiator: Sealed radioactive material used to irradiate other materials and that has the potential to create a radiation level exceeding 500 rad (5 grays) in 1 hour at 1 meter. Although not addressed in this Standard, acceptable radiological controls for irradiator use are specified in Title 10, Code of Federal Regulations, Part 36.

lifetime dose: Total occupational dose over a worker's lifetime, including external and internal dose.

low-level waste: Waste that contains radioactive material and is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in Section 11e(2) of the Atomic Energy Act, as amended. Test specimens of fissionable material irradiated only for research and development and not for production of power or plutonium may be classified as low-level waste provided the concentration of transuranic activity is less than 100 nCi/g.

Member of the public means an individual who is not a general employee. An individual is not a "member of the public" during any period in which the individual receives an occupational dose [**10 CFR 835.2(a)**].

Minor means an individual less than 18 years of age [**10 CFR 835.2(a)**].

Monitoring means the measurement of radiation levels, airborne radioactivity concentrations, radioactive contamination levels, quantities of radioactive material, or individual doses and the use of the results of these measurements to evaluate radiological hazards or potential and actual doses resulting from exposures to ionizing radiation [**10 CFR 835.2(a)**].

Occupational dose means an individual's ionizing radiation dose (external and internal) as a result of that individual's work assignment. Occupational dose does not include doses received as a medical patient or doses resulting from background radiation or participation as a subject in medical research programs [**10 CFR 835.2(a)**].

Person means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency, any State or political subdivision of, or any political entity within a State, any foreign government or nation or other entity, and any legal successor, representative, agent or agency of the foregoing; provided that person does not include DOE or the United States Nuclear Regulatory Commission.
[**10 CFR 835.2(a)**].

Personal protective equipment: Equipment such as respirators, face shields, and safety glasses used to protect workers from excessive exposure to radioactive or hazardous materials.

personnel dosimeters: Devices designed to be worn by a single individual for the assessment of equivalent dose such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

personnel monitoring: Systematic and periodic estimate of radiation dose received by individuals during working hours. Also, the monitoring of individuals, their excretions, skin, or any part of their clothing to determine the amount of radioactivity present.

planned special exposure: Preplanned, infrequent exposure to radiation, separate from and in addition to the annual dose limits.

prenatal radiation exposure: The exposure of an embryo/fetus to radiation.

primary dosimeter: A dosimeter worn on the body used to obtain the formal record of whole body radiation dose.

protective clothing: Clothing provided to personnel to minimize the potential for skin and personal and company-issued clothing contamination. Also referred to as "anti-contamination clothing," "anti-Cs," and "PCs."

qualification standard: The explicit performance requirements for minimum proficiency in technical, academic, and site-specific knowledge and practical skills used in determining satisfactory completion of training programs. The qualification standard is used to qualify radiological control technicians at DOE facilities.

rad: Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram (0.01 gray).

Radiation means ionizing radiation: alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio waves or microwaves, or visible, infrared, or ultraviolet light [**10 CFR 835.2(a)**].

Radiation area means any area, accessible to individuals, in which radiation levels could result in an individual receiving an equivalent dose to the whole body in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates [**10 CFR 835.2(a)**].

radioactive material: Any material that spontaneously emits ionizing radiation (e.g., X- or gamma rays, alpha or beta particles, neutrons). The term “radioactive material” also includes materials onto which radioactive material is deposited or into which it is incorporated. For purposes of practicality, both 10 CFR 835 and this Standard establish certain threshold levels below which specified actions, such as posting, labeling, or individual monitoring, are not required. These threshold levels are usually expressed in terms of total activity or concentration, contamination levels, individual doses, or exposure rates.

radioactive material area: Any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values provided in Appendix E of 10 CFR 835

Radioactive material transportation means the movement of radioactive material by aircraft, rail, vessel, or highway vehicle. Radioactive material transportation does not include preparation of material or packagings for transportation, storage of material awaiting transportation, or application of markings and labels required for transportation [**10 CFR 835.2(a)**].

radioactive waste: Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, and is of negligible economic value considering the cost of recovery.

radioactivity: A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy and/or particles from their nuclei and, thus change (or decay) to atoms of a different element or to a lower energy state of the same element.

radiography: Examination of the structure of materials by non-destructive methods, using a radioactive source or a radiation generating device.

Radiological area means any area within a controlled area defined in this section as a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area” [**10 CFR 835.2(a)**].

radiological buffer area (RBA): An intermediate area established to prevent the spread of radioactive contamination and to protect personnel from radiation exposure.

radiological control hold point: Cautionary step in a technical work document requiring the radiological control organization to perform some action or verification. The radiological control hold point requirements should be satisfactorily completed before the work is continued.

radiological control technician: A radiological worker whose primary job assignment involves assessment of workplace radiological conditions, specification of protective measures, and provision of assistance and guidance to other individuals in implementation of radiological controls.

radiological label: Label on an item which indicates the presence of radiation or radioactive materials.

radiological posting: Sign, marking, or label that indicates the presence or potential presence of radiation or radioactive materials.

radiological work: Any work that requires handling of radioactive material or access to radiological areas.

radiological work permit (RWP): Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The radiological work permit serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions.

Radiological worker means a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 Sv) per year total effective dose [**10 CFR 835.2(a)**].

Real property means land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures [**10 CFR 835.2(a)**].

Real-time air monitoring means measurement of the concentrations or quantities of airborne radioactive materials on a continuous basis [**10 CFR 835.2(a)**]. Also see "continuous air monitor."

refresher training: Training scheduled in the alternate year when full training is not completed for Radiological Worker I and Radiological Worker II personnel.

release to uncontrolled areas: Release of material from administrative control after confirming that the residual radioactive material meets the requirements in DOE O 5400.5.

rem: Unit of equivalent dose and effective dose.

removable contamination: Radioactive material that can be removed from surfaces by non-destructive means, such as casual contact, wiping, brushing, or washing.

Respiratory protective device means an apparatus, such as a respirator, worn by an individual for the purpose of reducing the individual's intake of airborne radioactive materials [**10 CFR 835.2(a)**].

Sealed radioactive source means a radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of non-radioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators [**10 CFR 835.2(a)**].

senior site executive: That person at a DOE contractor-operated facility or site who has final on-site corporate authority and is often called the President, General Manager, Site Manager, or Director.

sievert (Sv): SI unit of any of the quantities expressed as equivalent dose. The equivalent dose in sieverts is equal to the absorbed dose in grays multiplied by the radiation weighting factor (1 Sv = 100 rems).

site: An area managed by DOE where access can be limited for any reason. The site boundary encompasses controlled areas.

soil contamination area: An area in which soil contamination is present at levels that are not releasable in accordance with DOE's environmental protection standards.

Source leak test means a test to determine if a sealed radioactive source is leaking radioactive material [**10 CFR 835.2(a)**].

standard radiological warning trefoil: Symbol designed and proportioned as illustrated in ANSI N2.1.

step-off pad: Transition area between contaminated and non-contaminated areas that is used to allow exit of personnel and removal of equipment.

sticky pad: Step-off pad provided with a tacky surface to reduce the potential for inadvertently tracking contamination out of a contaminated area.

Stochastic effects means malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold, for radiation protection purposes [**10 CFR 835.2(a)**].

survey: An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

technical work document: A term used to generically identify formally approved documents that direct work, such as procedures, work packages, or job or research plans.

thermoluminescent dosimeter (TLD): Radiation monitoring device used to record the exposure of personnel or areas to certain types of radiation.

transferable contamination: The total contamination levels, expressed in terms of disintegrations per minute per 100 cm^2, on items such as shoes, shoe covers, vehicle tires, tools, or other equipment which have come into contact with contaminated soils.

transuranic waste: Without regard to source or form, waste that is contaminated with alpha-emitting transuranic radionuclides having half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay.

Very high radiation area means any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates [**10 CFR 835.2(a)**].

Visitor: Any individual other than General Employees who are entering the WVDP site on official business on a temporary basis (i.e., less than forty hours in the period of one year), e.g., members of the public, tour groups, and visiting dignitaries.

week: A period of seven consecutive days [see 835.2(a)].

whole body dose: The sum of the effective dose for external exposures and the committed effective dose for internal exposures.

Year means the period of time beginning on or near January 1 and ending on or near December 31 of that same year used to determine compliance with the provisions of this part. The starting and ending date of the year used to determine compliance may be changed, provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years [**see 10 CFR 835.2(a)**].

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11 (Cont.)	Article 422.2.C, added	4-14	
	Article 431.1.A, added	4-20	
	Table 4-2, added	4-23	
	Article 451.4.A, deleted	4-35	
	Article 511.1.A, revised	5-1	
	Article 511.11, revised	5-4	
	Articles 511.13 - 511.14, revised	5-4 - 5-5	
	Article 514.4, revised	5-11	
	Article 521.7, revised	5-16	
	Article 551.1.A, revised	5-37	
	Article 554.9, revised	5-44	
	Article 555.12, added sentence	5-47	
	Article 562.4, added items A and B	5-51	
	Article 631.14, revised	6-11 - 6-12	
	Article 713.5, revised	7-4	
	Articles 752 - 754, revised numbering	7-17 - 7-18	
	Article 774.1, revised	7-22	
	Article 782, sentence added	7-23	
	Chapter 10, updated references	10-1 - 10-12	
FC1	Article 322.2.D.3, revised	3-9	06/14/96
	Article 322.15, revised	3-12	
	Article 324.4.A, added	3-14	
	Articles 511.15.C, 511.15.E - 511.15.G	5-6	
	Article 521.5.A, revised	5-15	
	Article 622.6.A, revised	6-9	
FC2	Article 332.4, revised	3-16	06/28/96
	Article 332.5, revised	3-16	
FC3	Article 322.2.D.3, revised	3-9	10/22/96
FC4	Article 511.5.C, added	5-2	12/27/96
	Article 521.4.D, added	5-15	
	Repaginate	5-1 - 5-26	
FC5	Articles 352.1 through 352.5, revised	3-36	02/12/97
FC6	Article 313 notation, revised	3-5	05/30/97
	Article 531.7, revised	5-28	
	Article 531.11, revised	5-30	
FC7	Article 313 notation, revised	3-5	07/09/97
	Article 633.4, added sentence	6-15	
FC8	Table 2-2, revised text and table	2-18 & 2-19	12/19/97

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FC8 (Cont.)	Article 322.2, revised Article statement	3-9	
	Article 421.11, deleted	4-14	
	Article 642.9.B.2 and 4, deleted	6-20	
12	Minor Revision to Incorporate field changes and repaginate document	All	03/09/98
FC1	Article 215.5, revised	2-9	04/09/98
	Article 322.3A, revised	3-11	
FC2	Article 512.2B, revised	5-8	05/13/98
	Article 522.2C, revised	5-21	
	Article 562.20, deleted 2nd sentence	5-51	
	Articles 631.19 and 631.20, added	6-13	
	Article 632.8, revised	6-14	
	Article 642.9E4, deleted	6-20	
	Article 642.10, revised	6-20	
	Article 643.2A and 643.2B, added	6-22	
	Article 643.8, deleted	6-22	
	Repaginated to allow for Page Change	6-1 - 6-29	
FC3	Article 134.7, Added	1-24	06/15/98
	Article 141.5B, Deleted	1-27	
	Article 143.3, Added	1-30	
	Article 211.5C4, Deleted	2-3	
	Table 2-2, Added text	2-18	
	Article 342.15, Added text	3-28	
	Article 342.17, Added	3-29	
	Article 346.8, Added	3-32	
	Article 347.6, Added	3-33	
	Article 365.7, Added	3-41	
	Article 431.6, Revised	4-20	
	Articles 562.1C and 562.1D, Added	5-50	
	Article 611.4, Added	6-1	
	Article 613.6A, Added	6-4	
	Article 621.7, Revised	6-8	
	Article 622.6A, Revised	6-9	
	Articles 622.6B and 622.6C, Deleted	6-9	
	Article 651 notation, Deleted	6-25	
	Articles 651.1 and 651.2, Added	6-25, 6-25a, 6-25b	
	Article 652.1, Added	6-25	
	Article 654.6, Added	6-26	
	Article 655.1, Added	6-26	
	Article 661 notation, Revised	6-28	
	Article 662, notation, Revised	6-28	
	Article 663 notation, Revised	6-29	

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FC3 (Cont.)	Article 712.7, Added	7-3	
	Chapter 10, References Added	10-5, 10-7, 10-7a, 10-7b, 10-12, 10-12a	
13	Minor Change Revision		07/29/98
	Table of Contents, deleted Table 7-1	i-xii	
	Article 127.1 & 127.2, revised text	1-13	
	Article 211.6, 211.6A, & 211.6B, revised	2-3	
	Table 2-2, revised text on removable limit	2-16	
	Appendix 2A.2E, revised DOE Order ref.	AP-2A-3	
	Appendix 2C.3, revised DOE Order ref.	AP-2C-1	
	Article 322.14B, revised WVDP doc. ref.	3-12	
	Article 348.2, added text	3-29	
	Article 351.6, revised WVDP doc. ref.	3-31	
	Article 352.4, revised WVDP doc. ref.	3-32	
	Article 422.2, deleted text	4-13	
	Article 422.7, revised DOE & WVDP doc. ref.	4-13	
	Article 423.17 & 423.18, revised DOE Order ref.	4-17	
	Article 441.13A, revised DOE & WVDP doc. ref.	4-26	
	Article 441.14C, revised DOE Order ref.	4-27	
	Article 443.7, deleted DOE doc. ref.	4-30	
	Article 451.4C2 & 451.5A, revised DOE & WVDP doc. ref.	4-32	
	Article 451.18, revised DOE & WVDP doc. ref.	4-36	
	Article 453.5, revised DOE & WVDP doc. ref.	4-39	
	Article 453.7D, added wording	4-40	
	Article 453.11, revised DOE & WVDP doc. ref.	4-41	
	Article 522.11C4, revised ANSI reference	5-22	
	Article 531.2, revised text	5-23	
	Article 531.8, revised WVDP doc. ref.	5-24	
	Article 531.11B, revised text	5-25,5-26	
	Article 532.2, revised WVDP doc. ref.	5-26	
	Article 621.7, revised text	6-8	
	Article 622.6, revised text	6-9	
	Chapter 7 TOC, deleted Table 7-1	7-i	
	Article 712.3, revised text	7-2	
	Article 712.6, revised text	7-3	
	Table 7-1, deleted	7-4	
	Article 722.1A, 722.1C, & 722.1D, revised DOE Order ref.	7-5, 7-6	
	Article 722.15, revised DOE Order ref.	7-8	
	Article 741.2, revised text & DOE Order ref.	7-12	
	Article 782, revised DOE Order ref.	7-19	
	Chapter 10 References, added/revised	10-3, 10-4, 10-5, & 10-10	

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
FC1	Article 322.2.D.4, added wording	3-9	10/06/98
FC2	Chapter One, Table of Contents, revised		01/18/99
	Article 116 page reference	1-i	
	Article 114.8, revised text	1-5,1-6	
	Repaginated pages 1-5 through 1-7 to allow for page change	1-5 - 1-7	
	Article 411.6B, added text	4-2	
	Article 451.20, added	4-37	
FC3	Article 322.2.D.3, added text	3-9	03/30/99
	Article 322.2.D.4, revised text	3-9	
	Article 322.2.D.5, Deleted	3-9	
	Article 322.2.D.6, Deleted	3-9	
	Article 322.2.D.7, Deleted	3-9	
	Article 322.2.D.8, Deleted	3-9	
	Article 322.2.D.9, revised text	3-9	
	Article 322.3.A, Deleted	3-9	
	Article 322.3.B, Deleted	3-10	
FC4	Section 414.16 - Changed containerization criteria to reference WVDP-304.	4-10	05/21/99
	Section 453.7D - In the last sentence of the section, changed "125" to "100."	4-40	
FC5	Section 114.8 - Revised text	1-5 & 1-6	06/02/99
	Section(s) 114.8 A & 114.8 B - DELETED	1-6	
14	New-Type Revision Incorporation of field changes	All	06/15/99
15	General Revision	All	11/05/99
FC1	Table of Contents, revised	3	12/31/99
	Article 114.8, revised	11-12	
	Articles 133.1A and 133.1C, revised	23	
	Articles 133.1D and 133.1E, added	23	
	Article 236.1A, added	61	
	Article 322.1A, second and third bullets, revised	83	
	Article 322.11A, deleted first sentence	86	
	Article 322.14, deleted	87	
	Article 323.3A, deleted	87	
	Article 334.15, added	93	
	Article 346.6, revised	104	
	Articles 411.5F and 411.5G, added	141	

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
FC2	Article 441.19, added	168	02/24/00
	Pages 168 & 169 repaginated to allow for page change	168-169	
FC3	Article 238.1.D. revised	62	07/05/00
FC4	Article 132.4.A and 132.4,B, deleted	25	11/09/00
	Document repaginated for E-DOCS	All	
FC5	Appendix 3B.2.A & 3B.2.B, deleted	126	12/14/00
16	NEW-TYPE REVISION INCORPORATION OF FIELD CHANGES	All	01/04/01
FC1	Article 211.3A, added clarifying text	40	01/31/01
	Article 211.6A, added reference to step	41	
	Article 211.6D, added statement for approved organizations with 1000 mrem/yr ACL	42	
	Table 2-1, added footnote #8	47	
	Article 411.5.D, added text for clarity	145	
	Article 414.18, deleted DOE O 5820.2A requirements	154-155	
	Article 414.19, deleted DOE O 5820.2A requirements	155	
	Article 421.11, added reference for animal/wildlife policy	158	
	Article 422.12, added policy for animals/wildlife for WVDP	161-163	
	Article 423.18, deleted DOE O 5820.2A requirements	163	
	Article 423.20, revised DOE O 5820.2A to 435.1	163	
	Articles 441.1 - 441.3, revised DOE O 5820.2A to 435.1	166	
	Articles 441.4A and 441.5 - 441.7, revised DOE O 5820.2A to 435.1	167	
	Articles 441.6 - 441.11, deleted DOE O 5820.2A requirements	167-170	
	Articles 441.13.A.3 and 441.13.C, revised DOE O 5820.2A to 435.1	170	
	Articles 441.14.A.4 and 441.14.G, revised DOE O 5820.2A to 435.1	171	
	Article 442, revised DOE O 5820.2A to 435.1	172-173	
	Article 451, revised DOE O 5820.2A to 435.1	175	

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
FC1 (Cont.)	Article 451.19.G, revised DOE O 5820.2A to 435.1	181	
	Chapter 10, revised reference to WV-986	376	
FC2	Article 115.1, added item A	15	05/08/01
	Article 133.1.A, revised text	25	
	Article 138.2, added item A	31	
	Article 141.5.C, revised managers list	33	
	Article 215.6, change manager title	46	
	Article 322.1.A, revised text	87	
	Article 332.1, added text	94	
	Article 334.2.A, revised text	95	
	Article 342.10, changed “is” to “should”	104	
	Article 351.3.A, deleted first two sentences	111	
	Article 365.9, changed should to shall	117	
	Article 414.12, deleted duplicate sentence	153	
	Article 453.6.B, revised text	184	
	Article 453.7.D, revised text	185	
	Article 521.7, changed LITCO to INEEL Contractor	204	
	Article 523.7, changed LITCO to INEEL Contractor	212	
	Article 531.12.B, deleted second sentence	216	
	Article 531.14, change “RP” to “S&EM” Dept.	216	
	Article 541.4.C, revised manager’s title	219	
	Articles 555.13.A and 555.14.D, revised text	232	
	Article 562.2.A, revised manager’s title	234	
	Article 562.3, added text	235	
	Articles 621.7 and 621.8, revised text	246	
	Article 622.6, revised text	247	
	Article 641.1, revised last sentence	253	
	Glossary - visitor, added definition	391	
FC3	Articles 141.5.C and 141.5.C.1, revised manager’s title	33	08/08/01
	Article 215.6, revised manager’s title	46	
	Article 414.20, added text for clarification	155	
	Article 451.1.C.3, added text for clarity	176	
	Article 541.4.C, revised manager’s title	219	
FC4	Article 121.8.B, Revised department name	19	05/08/02
	Article 141.5.B, Revised manager’s title, added text for clarification	32	
	Article 141.5.C, Revised manager’s title	33	
	Article 141.5.C.1, Revised manager’s title	33	
	Article 211.6.D, Delete first bullet	42	
	Article 215.6, Revised manager’s title	46	
	Article 322.13.B, Revised department name	90	

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FC4 (Cont.)	Article 453.5.B, Replace WV-987 with WVDP-242	184	
	Article 531.C.2, Revised name of organization	213	
	Article 531.8.C, Revised department name	214	
	Article 531.14, Revised name of organization	216	
	Article 541.4.C, Revised manager's title	219	
	Article 632.7, Revised department name	251	
	Article 712.4.A, Revised department name	267	
	Article 712.6.B, Revised department name	267	
	Article 741.1, Revised department name	275	
	Chapter 10, Delete reference to WV-987	376	
	The Rad Prot Department affected by these changes		
17	Minor Change, incorporated previous field changes and renumbered Article sections appropriately. No text changes were made.	All	05/24/02
	No organizations are affected.		
FC1	Article 441.9.A, Change "100 mr/hr" to "200 mr/hr".	166	10/02/02
	Article 441.9.B, Change "100 mr/hr" to "200 mr/hr".		
	The Rad Prot Department affected by these changes.		
FC2	Article 451.9, Change "Environmental Quality Assurance Plan" to "Environmental Compliance Standards"	172	03/18/03
	Chapter 10 References, Change "Environmental Quality Assurance Plan" to "Environmental Compliance Standards"	364	
	Article 712.4A, Change "Section 4.10" to "Section 4.11" and Change "Articles 725 and 731" to "Article 725".	262	
	Article 712.6, Change "ASME NQA-1" to "QM-2"	262	
	Article 531.9A, delete "ten percent of"	209	
	Technical Services is the only department affected by these changes		
18	Deleted Step 121.8.C	20	05/23/03
	Renumber Steps 231.13 through 231.15	58	
	Delete words, "with those discussed" in Step 612.1. They were in the paragraph twice.	236	
	Technical Services and Training and Development Departments affected by these changes		

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19	General Revision		08/14/03
	Updated format of manual per DCIPs.		
	Changed WVNS to WVNSCO, and updated department and manager titles throughout	All	
	Article 113.3A, added reference to WV-905	13	
	Article 126.1, added A&PC survey of containers per Article 113 Determination	24	
	Article 134.7, revised document title	29	
	Article 141.5A and 141.5C, updated titles	32-33	
	Article 211.6D, added groups approved to receive 1 rem for WVDP annual ACL.	43	
	Article 211.7, revised event evaluation criteria	43	
	Article 215.6, updated DP Manager title	47	
	Article 231.7A, added Article 113 Determination	56	
	Article 237.1A, added definition of surface and subsurface	66	
	Article 238.1A, added definition of surface and subsurface	66	
	Article 313, added clarifying text for graded approach of requirements	83	
	Article 332.1, removed Article 113 Determination for RHWF RBA requirements	94	
	Article 335.11, added clarifying text for “hands on” work performed by visitors	99	
	Article 347.8A, added Article 113 Determination	109	
	Article 351.1A, changed Event Fact Sheet to Issue Report	111	
	Articles 352.6 and 352.7, removed “critiques” and reworded	113	
	Article 411.4, clarified using “unsealed” Radioactive materials	143	
	Article 441.1B, deleted 2nd sentence	165	
	Article 511.6B, revised text to deep and shallow radiation terminology	192	
	Article 511.11, revised to include WVDP-401 and other DOELAP documents	193	
	Article 511.14A, revised “visitor” to “temporary”	194	
	Article 512.2C, added statement indicating that extremity dosimeters are now under DOELAP	195	
	Article 512.7E, added item to consider DRD and ED results	196	
	Article 513.2A, revised pocket to direct-reading	197	
	Article 521.14E, added referral to work restrictions	204	

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
19 (Cont.)	Article 522.2A, added reference to WVDP-390 and removed text concerning when DOELAP is effective	205	
	Article 541.4C, revised text to RP management	216	
	Article 552.1F, added Article 113 Determination	222	
	Article 555.9A, added Article 113 Determination	228	
	Article 621.3A, added RP management approval	242	
	Article 621.8, clarified GET requirement	243	
	Article 651.2B, revised document title	257	
	Article 661, revised document title	260	
	Chapter 10, updated numerous references	358-367	
	These changes affect personnel involved in radiological work activities.		
20	General Revision		03/02/04
	Added clarification to Article 138.2.A concerning review of external program assessments.	31	
	Revised Article 141.5A through 5C manager titles.	32-33	
	Revised Article 211.6.D to clarify WVDP organizations having an ACL of 1000 mrem/year.	43	
	Revised Article 211.7 to remove redundant text concerning evaluating exposures per WVDP-242.	43	
	Revised Article 312.4.E.1 to include ALARA trigger level for offsite dose to member of public exceeding 0.1 mrem per year.	80	
	Added definition to Article 315.3 for significant adverse radiological conditions.	85	
	Added Article 654.7 to reference to WVDP-423	259	
	Revised Article 713.1C to include Article 113 Determination for using blue ink.	265	
	Chapter 8, removed reference to footnote 5	299-301	
	Chapter 10, updated HPS N13.6 & N13.11, DOE Order 231.1A and 231.2A, and WVDP-423 references.	358,363,&367	
	This change affects Radiation Protection and Field Operations (D&D/WM Operations) organizations.		
21	Revision		08/11/04
	Articles 338.9 and 338.13 were revised to clarify postings regarding alarming friskers.	101	
	Article 414.11B was revised to add other types of emergency preparedness training.	152	
	Article 422.13 added to describe process knowledge use in evaluating items for unrestricted release.	159-160	
	This change affects Emergency Management and Radiation Protection staff.		

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
22	General Revision This revision was made in response to a Change Notice for DOE-STD-1098-99 (DOE Radiological Control Standard) where several references (e.g., DOE Orders, standards, etc.) were updated. In addition, several other references were updated in this manual that have been superceded by revisions. Replaced INEEL with INL throughout. Article 512.4A was added from DOE Guide 441.1-4 guidance. Requirements for completing form WV-3194 in Article 631.13 and annually reviewing radiological worker qualification in Article 631.14 have been deleted. This revision affects the Radiation Protection organization and Training and Development Department.	All	02/22/05
23	Major Revision Article 312.4.C.1 was revised to clarify the high contamination ALARA trigger level. Article 342.17 was added to specify monitoring requirements for moving equipment and materials. Article 555.9A, second sentence was revised to delete job-specific air samplers from Article 113 Determination for preliminary assessments of air samples. Updated references in Chapter 10. Articles 322.7A, 365.12, 511.3B, 511.14G, 513.1, 513.4, 513.8, and 633.1H were revised to address discontinued use of DRD's as supplemental dosimetry. This revision affects Radiation Protection organization and radiological workers.	72 95 207 323 & 325 80,107,175,178,180,181,228	03/07/05
24	Minor Revision Article 141.5.C, removed text referring to TS Manager and revised items 1 and 2 with current RP staff Article 215.6, removed manager title Article 512.4.A, clarified text to refer to 514.4 definition for non-uniform radiation fields. Rad Protection department affected by these changes	29-30 42 179	08/16/05
25	Major Revision Article 121.8A, Deleted reference to WV-538 annual training plan Article 321.4, Deleted RWP requirement for indicating limiting conditions in special instruction block. Article 322.7A, Revised requirement for recording supplemental dosimeter results on RWP to RSO toolkit. Article 322.9, Deleted RWP requirement for indicating limiting conditions in special instruction block. Article 322.11, deleted requirement of time recorded on RWP. Article 322.13, deleted requirement for including personnel exposure data on RWP.	18 78 80 81 81 82	03/24/06

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Rev. No.	Description of Changes	Revision On Page(s)	Dated
25 (cont'd)	Article 712.4D, revised Human Resources to Employee Health Services.	242	
	Article 713.2A, Added clarification for maintaining signatures and Initials of radiological control personnel	243	
	Article 722.1.E, revised requirement for sending SDE's to INL to maintaining the SDE at the WVDP.	245	
	Radiological workers and Radiation Protection organization are affected by this revision.		
26	Revision Changed RP Manager to R&S Manager throughout manual. Changed RP organization to radiological control organization throughtout manual for consistency with DOE RCS terminology. Deleted RPO Manager and replaced with R&S Manager throughout. Article 513.1B, revised wording to include RSO Toolkit program use. Article 641.1, deleted last sentence on qualification timeframe. Article 642.8, deleted RCT B and RCT A experience requirement. Article 644.1A, revised oral board requirement to complete after RCT A qualification. Article 645.2.C, revised last sentence to clarifiy approximately every 2 years for over-train tasks. This revision affects the radiological control organization.	All	08/31/06
27	Revision Changed based on Article 113 Determination Number 42 to allow hand frisking when reaching into a contamination area from a radiological buffer area. This revision affects Radiation and Safety.	91	11/08/06
28	Major Revision Revised to incorporate DOE-STD-1098-2008 This revision affects Radiation Safety and all Radiological Workers.	All	03/03/09
29	Minor Revision to correct typographical errors and formulas and information in Article 555.16 & 17 This revision affects Radiation Safety and all Radiological Workers.	175, 176	03/24/09
30	Minor revision to correct editorial and typographical errors Changed the wording in Article 211.4.D Added a step on Article 464 Article for a 113 determination This revision affects Radiation Safety and all Radiological Workers.	All 36 148	04/27/10