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8. Description of Change and Justification

This revision to the TFRM incorporates Changes to create a new Article 239 "Internally and Potentially Contaminated Systems" to allow "At the discretion of the Project/Activity Radiological Control Manager, signs may be posted at the entrances to buildings, rooms, or areas informing individuals that an area contains internally and/or potential internally contaminated systems".

Also updated are references to DOE Orders 460.1B, 451.1, 414.1C, 231.1-A 232.1-2, 421.1B to current orders Article 423 to DOE O 460.1C, Article 451 to DOE O 451.1B, Article 743 to DOE O 424.1D, Article 721 and 782 to DOE O 231.1B, Article 127 will delete the the reference to the cancelled DOE M 231.1-2.

The reference in Article 431.12 of the Tank Farms Radiological Control Manual will be replaced with the current DOE O 231.1B which superceded DOE N 234.1.

9. TBDs or Holds N/A

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a. Related Building/Facilities <input checked="" type="checkbox"/> N/A	b. Related Systems <input checked="" type="checkbox"/> N/A	c. Related Equipment ID Nos. (EIN) <input checked="" type="checkbox"/> N/A
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HNF-5183, Rev. 50

Tank Farm Radiological Control Manual

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Abstract: This document provides the basis for maintaining compliance with 10 CFR 835, "Occupational Radiation Protection".

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APPROVED

By Lynn M. Ayers at 1:30 pm, Apr 01, 2019

Release Approval

Date

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**Tank Farms
Radiological Control Manual
(TFRCM)
HNF-5183**

**Revision 50
Effective December 31, 2018**

Copy No. _____

RECORD OF REVISION		(1) Document Number: HNF-5183		Page <u>1</u>
(2) Title: Tank Farm Radiological Control Manual				
Change Control Record				
(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release		
		(5) Resp. Engr. (print/sign/date)	(6) Resp. Mgr. (print/sign/date)	
5	<ul style="list-style-type: none"> • 101 changes to make the requirements a verbatim flow down from the governing documents (Radiation Protection Plan, Health and Safety Document, and 10 CFR 835). • 1 change to appendix 3D. This change clarified the need to perform a source check. 	Stephen R. Johnson	Edward J. Adams	
5a	<p>Incorporated changes to High Radiation Area Access Control requirements as approved by DOE-ORP, from 100 mrem/hr to 1.0 rem/hr.</p> <p>Minor changes to Articles 365.1 and 365.2 to update references, and changed Article 413.4 to clarify wrapping requirements for radioactive materials, and changed article 713.2 to reflect responsibility for maintaining signature files.</p>	Stephen R. Johnson	Edward J. Adams	
5b	<p>Incorporated a number of changes to the TFRCM as approved by the WRPS RadCon Forum. These changes include actions proposed by TFC-1105-FACT-0178, TFC-1105-FACT-0180, TFC-1106-FACT-0184, and TFC-1106-FACT-0188, plus a number of minor typographical and formatting corrections. Affected TFRCM sections include Articles 118.2, 142.5; Appendix 2C; Articles 351.4, 361, 363 and Chapter 3 Part 7; Articles 412.1, 413.1, 431.11, 462.5, 535.1, 551.9, 713.1(e) and 741; and the Glossary definition of "Radiological Work".</p>	Stephen R. Johnson	Edward J. Adams	
5c	<p>Incorporated changes to Articles 113.1, 132.2, 231.9, and 521.1e as approved by the WRPS Forum on TFC-1201-FACT-0224.</p>	Stephen R. Johnson	Edward J. Adams	
5d	<p>Incorporated Forum-approved modifications to Articles 338.1, 338.4, Appendix 3C.5, Appendix 3C.8, Appendix 3C (Removal Sequence) step #4, Article 414.1, and Appendix 2C (4 new posting signs).</p>	Stephen R. Johnson	Edward J. Adams	
5e	<p>Incorporated WRPS RadCon Forum-approved modifications to Article 365 on RGD's approved in FACT TFC-1208-FACT-0244, and to Article 321 on RWP voids approved in FACT TFC-1208-0245.</p> <p>Changes to Article 141 adding the 10 CFR 835.103 implementing provision language per PER-2012-1115.</p>	Stephen R. Johnson	Edward J. Adams	
5f	<p>Modify the following chapters of HNF-5183 to incorporate the changes authorized by the WRPS RadCon Forum: Chapter 2 (revise Table H2-1), Chapter 3 (Article 343 and Appendix 3C), and Chapter 5 (remove Article 521.1e and delete related Tables 5-1, 5-2, and 5-3).</p>	Stephen R. Johnson	Edward J. Adams	
5g	<p>Modify the following chapters of HNF-5183 to incorporate the changes authorized by the WRPS RadCon Forum: Chapter 3, Table 3-1(modify to match</p>	Stephen R. Johnson	Edward J. Adams	

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	the HSD) and Chapter 6, Article 635.2 (delete). Also replaced references to DOE O5400.5 with DOE O458.1.		
5h	Incorporated changes to HNF-5183 as authorized by the WRPS RadCon Forum. These include TFC-1307-FACT-0275, TFC-1307-FACT-0276, and TFC-1308-FACT-0277. FACT-0275 affected Articles 132, 133, 138, 142, 231, 322, 325, 338, 342, Appendix 3C, Table 3-3, 411 and 421. FACT-0276 affected Article 511. FACT-0277 affected Articles 112,113 (et al), 115, 117, 118, Chapter 1 Part 2 intro,144 (et al), Chapter 2 Part 1 intro, 211, 213, Table 2-1, 214, 221, 222, 234, 238, 414, 431, 461 and 512. In addition, this change corrects minor typographical, spelling, formatting and grammatical errors throughout the manual.	Stephen R. Johnson	Edward J. Adams
5i	Incorporated changes to HNF-5183 as authorized by the WRPS RadCon Forum. These include TFC-1401-FACT-0286, TFC-1401-FACT-0289, and TFC-0402-FACT-0290. In addition, this change corrects several minor typographical, spelling, formatting and grammatical errors.	Stephen R. Johnson	Edward J. Adams
5j	Incorporate changes to HNF-5183 as directed by the WRPS RadCon Forum (TFC-1404-FACT-0298, TFC-1409-FACT-0304, and TFC-1404-FACT-0305). FACT-0298 updated the TFRM to reflect the updated ANSI calibration Standard for portable instrumentation. FACT-0304 implemented a Technical Equivalency Determination to modify the routine surveillance frequency for inactive SST Farms from weekly to monthly. FACT-0305 removed the self-imposed dimensional criteria from Appendix 2C to allow flexibility in radiological signage. These three FACTs affected the requirements in Articles 551.5, 564.1, 552.1.b, 554.1.f, 554.1.g, 554.1.h, and Appendix 2C. In addition, several administrative flaws were corrected that do not affect the requirements. The administrative corrections were for Articles 232, 236, 523, 711, 722, 753, and 755. These corrections fixed cross-references with the 10 CFR 835 Radiation Protection Program document (HNF-MP-5184) to render these two requirements documents consistent.	Stephen R. Johnson	Edward J. Adams
5k	Incorporate changes directed by the WRPS RadCon Forum (TFC-1412-FACT-0310, TFC-1506-FACT-0327, and TFC-1508-FACT-0331), plus it incorporates a corrective action to fix two errors identified in WRPS-PER-2015-0145). FACT-0310 eliminated the oral board examination process for the requalification of Radiological Control First Line Managers. FACT-0327 added two alternative postings, for Hot Spots and Radiation Generating Devices, to Appendix 2C of the TFRM. It also corrected Table 2-3 of the TFRM to eliminate an error implying that a Hot Spot is driven by 10 CFR 835 requirements. FACT-0331 made several minor changes: It removed "10 CFR 835" from the headers of Table 2-4; it removed a redundant posting	Stephen R. Johnson	Edward J. Adams

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	from Appendix 2C; it modified Article 322 to add the requirement for an RWP to be used when using HEPA vacuums; it clarified Article 464.5 by changing “highly contaminated areas” to “High Contamination Areas”; it added a reference to Article 522.1 regarding Allowable Limit on Intake Values; and it corrected a reference and clarified the wording of Article 555.5 regarding instrument calibration requirements. PER-2015-0145 corrected minor Dose Equivalent terminology errors in TFRCM Article 352 and the Glossary.		
5L	Changed Article 5.1.3.4 to read: Supplemental pocket or electronic dosimeters used for exposure control should be worn outside the personal 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. In other situations the supplemental or electronic dosimeter may be worn inside the personal protective clothing unless directed otherwise by Project/Activity Radiological Control. Approved by RadCon Forum document: TFC-1601-FACT-0345.	Stephen R. Johnson	Edward J. Adams
5M	This revision to the TFRCM incorporates two changes, both approved by the WRPS RadCon Forum. The first change, authorized by TFC-1602-FACT-0348, adds a new Table 3-1 to the TFRCM incorporate guidelines for selecting radiological personal protective clothing (PPE), and changes the numbering of former Tables 3-1 and 3-2, to 3-2 and 3-3. The second change, authorized by TFC-1606-FACT-0357, removes Article 513.7 from the TFRCM. The reason supplemental dosimeters are not typically worn for every entry, the majority of Tank Farm entries result in very low doses, and annual TLDs are the standard. Alternative and more appropriate methods exist for triggering investigations of questionable doses.	Jerry E. Kurtz	Edward J. Adams
5N	This revision to the TFRCM incorporates one change, approved by the WRPS RadCon Forum. This change adds a definition of “Immediately Adjacent” to the TFRCM Glossary. This change was authorized by TFC-1707-FACT-0375, titled “Contamination Control Procedure More Stringent than Radiological Control Manual.”	Peter B. Chadly	Jerry E. Kurtz
5O	This revision to the TFRCM incorporates one new article 239 as mandated and authorized by FACT TFC-1608-FACT-0359. It also updates references to Articles 127, 423, 431, 451, 721, 743, and 782.	Lee M. Livesey	Jerry E. Kurtz

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PART 1 Department of Energy (DOE) Radiological Control Standard

The Tank Farms Radiological Control Manual (TFRCM) provides the Tank Operations Contractor (TOC) basis for consistent and uniform implementation of radiological control requirements established by the Occupational Radiation Protection Final Rule, 10 CFR 835, and the commitments made in the TOC Radiation Protection Program, HNF-MP-5184 (hereinafter referred to as the TOC RPP). This Manual also implements the requirements of the Hanford Radiological Health and Safety Document (hereinafter referred to as HSD).

111 Radiological Control 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 this Manual 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 Department of Energy is firmly committed to having a Radiological Control program of the highest quality. This applies to those DOE activities that manage radiation and radioactive materials and that may potentially result in radiation exposure to workers, the public and the environment.

The TOC Radiological Control Policy shown below summarizes the elements of the Department of Energy Radiological Health and Safety Policy and is intended to guide the actions of every person involved in radiological work activities as defined by contract DE-AC27-08RV14800.

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TOC RADIOLOGICAL CONTROL POLICY

ALARA

Personal radiation exposure shall [835.1003(b)] be maintained As Low As Reasonably Achievable (ALARA). [RPP # 223]

No exposure to an individual or group of individuals shall [835.1003(b)] be authorized without the expectation of a net positive benefit from the authority. [RPP # 223]

All exposure shall [835.1003(b)] be kept as low as reasonably achievable, economic and social factors being taken into account. [RPP # 223]

The exposure to individuals shall [10 CFR 835, Subpart C] not exceed limits established by the Department of Energy.

OWNERSHIP

Each person involved in radiological work is expected to demonstrate responsibility and accountability through an informed, disciplined and cautious attitude toward radiation and radioactivity.

EXCELLENCE

Excellent performance is evident when radiation exposures are maintained well below regulatory limits, contamination is minimal, radioactivity is well-controlled and radiological spills or uncontrolled releases are prevented. Continuing improvement is essential to excellence in radiological control.

112 Manual Applicability and Control

This Manual is applicable to any radiological activity performed within the scope of contract DE-AC27-08RV14800. [TFC-PLN-100] Accordingly, the provisions in the Manual should be viewed by the TOC as an acceptable technique, method or solution for fulfilling their duties and responsibilities. Some of the Manual provisions, however, challenge the user to go well beyond minimum requirements. Following the course of action delineated in the Manual will result in achieving and surpassing related statutory or regulatory requirements.

The Manual is not a substitute for Regulations; it is intended to be consistent with all relevant statutory and regulatory requirements and guidance documents. The Manual should be revised whenever necessary to ensure such consistency. Furthermore, this Manual is a living document and the TOC intends to review and update provisions on a periodic basis to incorporate lessons learned and suggestions for improvement. Recommendations to correct or improve the TFRM are encouraged to be sent to the TOC Radiological Control Manager.

Changes that alter the requirements or revise the intent of the TFRM (e.g., changes to administrative control levels in Article 211) are provided to members of the TOC Radiological Control Forum for review and concurrence. All changes are approved by the TOC Radiological Control Manager.

This Manual should be used by DOE and the TOC to evaluate the performance of TOC radiological activities.

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DOE employees, DOE-sponsored visitors and personnel of other Federal and state agencies are subject to and shall adhere to the provisions of this manual and the TOC RPP when performing work in TOC managed facilities. Where there is no contractor for a DOE activity, DOE shall ensure implementation of and compliance with the requirements of 10 CFR 835.

1. This Manual implements the commitments made in the TOC RPP and contract DE-AC27-08RV14800.
2. *Except as discussed in this Article, these requirements shall [835.1(b)(1)-(b)(7)] not apply to:*
 - 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; [RPP # 3]*
 - b. *Activities conducted under the authority of the Deputy Administrator for Naval Reactors, as described in Public Law 98-525 and 106-65; [RPP # 4]*
 - c. *Activities conducted under the Nuclear Explosives and Weapons Surety Program relating to the prevention of accidental or unauthorized nuclear detonations; [RPP # 5]*
 - d. *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; [RPP # 6]*
 - e. *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; or [RPP # 7]*
 - f. *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 which has been approved by a Secretarial Officer in consultation with the Chief Health, Safety and Security Officer; [RPP # 8]*
 - g. *Radioactive material transportation not performed by DOE or a DOE contractor; [RPP # 9]*
 - h. *Occupational doses received as a result of excluded activities and radioactive material transportation, as listed in Article 112.2 (a-d and g), shall [835.1(c)] be included to the extent practicable when determining compliance with the occupational dose limits in Table 2-1 and Article 215. Occupational doses resulting from authorized emergency exposures and planned special exposures shall [835.1(c)] not be considered when determining compliance with the dose limits in Table 2-1. [RPP # 10]*
3. Except as specified in Article 112.2, the provisions of this Manual also apply in those cases where contractors or subcontractors are used to conduct DOE-funded radiological activities at non-DOE sites or facilities.
4. Hanford Site Records and Information Management provides document control services for the TFRCM. Appendices to the TFRCM contain supplemental information that may be useful in implementing the requirements of the TFRCM.

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113 Compliance

1. This Manual sets forth the TOC's policy on the proper course of action in the area of radiological control within the scope of DOE sponsored activities. If a user fully implements a provision, the user will have complied with, and most likely exceeded, any related statutory, regulatory, or contractual requirement.

Nothing in the TFRCM shall [835.3(d)] be construed as limiting actions that may be necessary to protect health and safety. [RPP # 19]

With respect to a particular DOE activity, contractor management shall [835.3(b)] be responsible for compliance with the requirements of this manual. [RPP # 17]

No person or DOE personnel shall [835.3(a)] take or cause to be taken any action inconsistent with the requirements of:

(1) 10 CFR 835; or

(2) Any program, plan, schedule, or other process established by 10 CFR 835. [RPP # 16]

For those activities that are required by Articles 134.1, 431, and 613, the time interval to conduct these activities may be extended by a period not to exceed 30 days to accommodate scheduling needs [835.3(e)]. [RPP # 20] Such extensions should be reviewed and approved by the Radiological Control Manager, and the reason(s) for requiring the extension should be documented.

2. The word "shall" identifies those elements that are directly attributable to a requirement. "Shall" when followed by [835.XXX], identifies those elements that are directly attributable to a requirement from 10 CFR 835 where the TOC has made an implementation commitment in the TOC RPP (text is highlighted in bold-italic font). Compliance with the 10 CFR 835 requirements is mandatory unless the TOC obtains an exemption from the requirement from DOE and identifies the exemption in the TOC RPP. The word "shall" followed by [HSD xxx] identifies those elements that are contractual requirements established by the Hanford Radiological Health and Safety Document. Compliance with an HSD requirement is mandatory unless DOE-ORP provides a contract modification. For purposes of regulatory and contractual compliance, users of this Manual are encouraged to refer to the source document to view the requirement in context. Title 10 CFR Part 820, Procedural Rules for DOE Nuclear Activities, establishes requirements for obtaining exemptions from regulatory requirements.
3. The word "should" means the TOC has the responsibility of either following the provision or demonstrating technical equivalency by an alternative solution. The use of "should" recognizes that there may be site- or facility-specific attributes that warrant special treatment and that literal compliance with the elements and requirements of the provision may not achieve the desired level of radiological control performance. In those cases where the TOC decides to follow an alternative technique, approach or method in lieu of the "should" provision, the following actions are required:
 - The alternative solution should be documented, with supporting technical basis, analysis and justification to demonstrate technical equivalency.
 - Prior to implementation, the approval of the TOC Radiological Control Manager and the TOC senior line manager responsible for operations should be required. DOE approval is not required

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nor expected.

- The documented justification, including the required approvals, should be readily retrievable for review and audit by DOE.

114 TFRCM

1. This Manual should be endorsed by the TOC senior site executive. The TOC senior site executive is that person at a DOE contractor-operated facility or site that has final on-site corporate authority and is often called the TOC Project Manager, General Manager, or Site Manager.
2. It is intended that the TFRCM will address unique situations and provide site-specific interpretation, clarification, or guidance. Substantive changes to this Manual should be endorsed by the TOC senior site executive.
3. Management policies, requirements, expectations and objectives for the site Radiological Control program should be clearly and unambiguously stated.
4. This Manual should be kept current and entered into the TOC document control system. Records & Document Control is responsible for configuration management of the TFRCM. Hanford Site Records and Information Management is responsible for document control for the TFRCM.
5. Subcontractors should comply with this Manual.

115 Application of Requirements

1. The requirements of this Manual apply to all DOE activities conducted by the TOC, as well as those performed on its behalf by subcontractors.
2. Reserved.

116 User Groups

1. DOE contractors are encouraged 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. Assignment of members to the user groups should be on a rotating basis.
2. The Hanford Radiological Control Forum (HRCF) consists of representatives of the Hanford site prime contractor's Radiological Control organizations and representative(s) of DOE-ORP and DOE-RL Radiological Control organization. The Chairperson of the HRCF should be selected on a rotating basis. The HRCF should meet periodically and at least quarterly. The activities of the HRCF include, but are not limited to:
 - Review of radiological control consistency issues
 - Review of Hanford radiological problems and successes.

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117 The “As Low As Reasonably Achievable” Process

10 CFR 835 requires DOE activities to develop and implement plans and measures to maintain occupational radiation exposures As Low As Reasonably Achievable (ALARA). 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 physical design features (including engineering 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 the provisions of this Manual generally 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 System

DOE requires its contractors to develop and implement an Integrated Safety Management System (ISMS) that integrates safety (including radiological safety) into management and work practices at all levels (see DOE Policy P 450.4 and its associated guidance documents). This Manual supports ISMS 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 Manual 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 ISMS, 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 this Manual as a guide to integrating radiological control measures into work planning and execution.
2. This Manual supports the ISMS guiding principles as follows:
 - Line Management Responsibility - This Manual clearly indicates that line management is responsible for ensuring adequate implementation of the radiological control program.
 - Clear Roles and Responsibilities - This Manual establishes clear roles and responsibilities for DOE and contractor line management and for the radiological control organization.
 - Competence Commensurate with Responsibilities - This Manual provides guidance for providing classroom and on-the-job training so those individuals may gain and maintain the appropriate competence.
 - Identification of Safety Standards and Requirements - This Manual provides cross-references to other DOE, Federal Agency, scientific, and consensus standards that are important to developing

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and implementing an effective and comprehensive radiological control program.

- Hazard Controls Tailored to Work Being Performed - This Manual 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).
3. Both the ISMS 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. This Manual provides guidance for implementing radiological controls that have been evaluated and found to meet the requirements of 10 CFR 835. For example:
- Chapter 3 of this Manual provides guidance for implementing access and egress controls for areas having specific radiological conditions and hazards.
 - Chapter 4 of this Manual provides guidance for implementing specific controls over radioactive materials.
 - Chapter 5 of this Manual provides guidance for performing radiological monitoring at specified frequencies consistent with known and likely radiological hazards.
 - Chapter 6 of this Manual provides guidance for providing training to ensure that individuals are able to discharge their responsibilities related to the radiological control program.

PART 2 Leadership in Radiological Control

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

121 Senior Management Commitment

1. Senior managers should establish high standards for the performance of radiological control. These standards and management expectations should be frequently communicated to the work force.
2. Senior managers should state in writing their firm commitment to a Radiological Control program of the highest quality. Management commitment and support are demonstrated 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 minimize radiation exposure and control radiological conditions, such as contamination.
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 person'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 adopt and promote a positive attitude toward radiological control that encourages initiatives to identify concerns at an early stage, to prevent problems from deteriorating and to promote doing the right job correctly the first time.
7. Prevention of the spread of radioactivity is less costly than remediation. Management should be willing to accept change that will improve radiological control and should foster this mindset throughout the organization.
8. Senior managers should require and approve radiological improvement goals. Goals should be measurable, realistic, auditable and challenging. Established goals should not be changed without technical justification and senior management approval. Senior management should review progress toward the goals at least quarterly.

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9. A performance indicator program for measuring and trending the effectiveness of the Radiological Control program against predetermined goals should be established and maintained.
10. 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.
11. Senior managers should be alert to opportunities for minimizing the generation of radiological waste and discharges to the environment, controlling contamination at its source and reducing radiation exposure to workers and the public.
12. Reporting a problem to a superior (contractor or DOE) does not absolve the manager from promptly fixing or mitigating a situation.

122 Worker Attitude

1. Minimizing worker radiation exposure can be achieved only if all persons involved in radiological activities have an understanding of and the proper respect for radiation.
2. Each worker should understand that proper radiological control is an integral part of his or her daily duties.
3. Improving the attitude of the work force should be supported by the training program. To achieve this, training personnel need to be knowledgeable about the work environment and those aspects of radiological control that are important to developing a better worker attitude and perspective.
4. The attitude that constant improvement is required in radiological work needs to be developed at all levels of management and in the work force. Cooperation between the work force and the Radiological Control organization has to be developed and fostered. The workers should not look upon radiological controls as hurdles or restrictions to be bypassed.
5. Radiological Control organization personnel should be helpful in showing workers how to follow the rules. This spirit of cooperation needs to be developed without subverting the control functions of the Health Physics Technicians. A situation in which radiological controls are left solely to the Radiological Control organization is unacceptable.

123 Worker Responsibilities

Trained personnel should recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work. The following radiological control rules are applicable to each person in the workplace. A poster that displays the worker responsibilities listed in Figure 1-1 should be produced and displayed at appropriate access points and work areas.

Figure 1-1, Worker Responsibilities

TO MINIMIZE YOUR RADIATION EXPOSURE AND CONTROL 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.

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 posted 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

Due to the continuing concerns of many people related to low radiation exposure and health impacts, managers should be trained to deal with the perception of personnel concerning radiation risks. Managers and first-line supervisors should be sensitive to the fact that workers have to understand the fundamentals of radiation, its risks and their role in minimizing exposure. It is not sufficient to rely solely on regulatory limits for establishing or defining acceptable work practices and work environments.

1. Appropriate personnel should receive training which is helpful in their dealing with workers who have anxiety about radiation. 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.
2. Some personnel, such as those who may have internal deposition of radionuclides from prior years, are concerned about future exposures. Such instances warrant special attention on the part of the manager. Counseling with such personnel should be the preferred way to consider relevant factors. In some cases special control levels (Article 216) should be applied.

125 Conduct of Radiological Operations

1. This Manual is consistent with the guidance in DOE O 422.1, "Conduct of Operations." The concepts of all chapters of DOE O 422.1 apply to the conduct of radiological control.
2. Managers at all levels are expected to be involved in the planning, scheduling and conduct of radiological work. Assurance of adequate radiological safety should not be compromised to achieve production, remediation or research objectives.
3. Supervisors should be technically knowledgeable and inquisitive and should ask 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 radiological deficiencies and concerns. Frequent inspections and walk-throughs, including off-hours and weekends (where appropriate), are essential to reinforce management expectations to the work force.
5. Managers, supervisors and workers should be involved in the development of accurate, clear, written procedures for performing radiological work. If during the use of procedures a written requirement cannot be responsibly followed, the work should be stopped and guidance obtained.
6. Supervisors and managers should encourage the work force to identify radiological control deficiencies and concerns. Prompt action should be taken to address and eliminate identified issues and prevent recurrence. Retraining, indoctrination and procedure review are useful in addressing these issues.

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7. Managers and supervisors should establish working conditions that encourage improved 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. A good Radiological Control program cannot exist in a sloppy, dirty workplace. Cleaning up after operations should be automatic for each person. It is not reasonable to expect radiological control to be separated from the work environment; they go together.
9. Subcontractors and subcontracted employees should be treated the same as facility staff in the area of radiological matters 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.
11. *Written procedures shall [835.104] be developed and implemented as necessary to ensure compliance with 10 CFR 835, commensurate with the radiological hazards created by the activity and consistent with the education, training, and skills of the individuals exposed to those hazards. [RPP # 39]*

126 Improving 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 changes may occur due to unforeseen reasons. Although the conduct of radiological surveys is viewed as a traditional role of Health Physics Technicians, experience has shown that properly trained and qualified workers are capable of performing supplemental radiological surveys in the course of work. This process results in exposure savings and improved 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 the 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 remains the responsibility of the Radiological Control organization.

127 Critiques

It is the department'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. The process, as described in Article 351, may be used to quickly establish facts in chronological order so that the underlying reasons or causes for the success or failure are well understood. Other processes can be used to capture the opportunities for improvement.

128 Facility Modifications and Radiological Design Considerations

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1. Radiological control performance is affected by human performance and engineered design features. This Manual primarily addresses the way people operate and use existing facilities and sites. General design criteria for new facilities and modifications to existing facilities are contained in 10 CFR 835 and DOE O 420.1C, "Facility Safety". ***In addition, the following radiological control design criteria shall [835.1002] be adopted for new facilities or modifications to existing facilities:***
 - a. ***Optimization methods shall [835.1002(a)] be used to assure that occupational exposure is maintained ALARA in developing and justifying facility design and physical controls. [RPP # 216]***
 - b. ***The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2000 hours per year) shall [835.1002(b)] be to maintain exposure levels below an average of 0.5 millirem (5 μ Sv) per hour and as far below this average as is reasonably achievable. [RPP # 217] The design objectives for exposure rates for potential exposure to a radiological worker where occupancy differs from the above shall [835.1002(b)] be ALARA and shall [835.1002(b)] not exceed 20 percent of the applicable standards in Table 2-1. [RPP # 218]***
 - c. ***Regarding the control of airborne radioactive material, the design objective shall [835.1002(c)] be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA; confinement and ventilation shall [835.1002(c)] normally be used. [RPP # 219 & 220]***
 - d. ***The design or modification of a facility and the selection of materials shall [835.1002(d)] include features that facilitate operations, maintenance, decontamination, and decommissioning. [RPP # 221]***
 - e. Discharges of radioactive liquid to the environment are covered by the provisions of DOE O 458.1 and should not degrade the groundwater.
 - f. Control of contamination should be achieved by containment of radioactive material.
 - g. Components should be selected to minimize the buildup of radioactivity.
 - h. Support facilities should be provided for donning and removal of protective clothing and for personnel monitoring, when required.
 - i. A neutron quality factor of 20 for conditions of unknown spectra (or doubling of the neutron quality factor associated with known neutron energies) should be used for design purposes. Design analyses based on these neutron quality factors are intended to be used to estimate the additional construction cost that would result if the neutron quality factor was increased. The results of these analyses should be used to ascertain the economic feasibility for incorporating such modifications in the final design.
2. Facilities currently under construction should be evaluated and the above criteria applied where practicable.

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PART 3 Improving Radiological Performance

131 Radiological Performance Goals

Goals are intended as a measure of and a motivation for improvement, not an end in themselves. These performance indicators are not to be viewed narrowly as numerical goals. These indicators should be used as tools to assist management in focusing their priorities and attention. The following are examples of goals that may be appropriate:

1. Collective Dose (person-rem): This goal should be based upon planned activities and historical performance. For those sites that have neutron radiation, a goal for collective neutron dose should also be established.
2. Skin and Personal Clothing Contamination Occurrences (number): Personnel contamination may indicate a breakdown of controls intended to prevent the spread of contamination.
3. Intakes of Radioactive Material (number): Personnel intakes of radioactive material should be minimized and management should focus attention on any failure of the controls that results in intakes.

132 Management of Radiological Performance Goals

1. The TOC senior site executive should establish, approve and maintain a radiological performance goals program.
2. The performance goals should be measurable, achievable, auditable, challenging, and meaningful in promoting improvement.
3. Reserved.
4. Radiological performance goals should be reviewed at least annually and revised as appropriate. Occasionally, a goal may be made less stringent to accommodate changes in workload or mission.

133 Radiological Performance Reports

1. The Radiological Control Manager should provide a periodic summary report to the TOC senior site executive. This report is suggested to be monthly but should not be less frequent than quarterly. This report should include at least the radiological performance goals established in accordance with Article 131. Examples of indicators that provide a more detailed analysis of performance are identified in Table 1-1. Indicators should be contained in the report for the month as well as tracking and trending for the prior twelve-month period.

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Table 1-1, Suggested Radiological Performance Indicators

<p>Exposure control</p> <ul style="list-style-type: none"> 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 administrative control level e. Number of dose assessments for lost or damaged dosimeters
<p>Personnel contamination</p> <ul style="list-style-type: none"> a. Number of skin and personal clothing contamination
<p>Control of internal exposure</p> <ul style="list-style-type: none"> a. Number of new confirmed depositions b. Number of unplanned exposures

The Radiological Control Manager should provide radiation exposure information, such as supplemental dosimeter readings, to supervisors and managers on a frequent enough basis to permit priority management of exposure control. The frequency should be consistent with the nature of the workload and the radiation exposure potential.

134 Assessments

Assessment, as used in this Manual, 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, including examination of program content and implementation, shall [835.102] be conducted through a process that ensures that all functional elements are reviewed no less frequently than every 36 months. [RPP # 37]*** These 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. Managers, supervisors and workers should look upon assessments as helpful. It is desirable to approach assessments with nothing to hide and with the Radiological Control program as an open book. Results of assessments should be incorporated into the ongoing process of improving radiological control.
3. Managers should encourage the positive view that identifying even minor deficiencies represents an opportunity for further improvement. The number of deficiencies does not in themselves measure the overall quality of the Radiological Control program. A prioritization system to implement actions for resolving the deficiencies should be implemented.

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4. In developing corrective action plans for assessment activities, managers should address basic underlying reasons for the identified deficiencies or concerns, not just the specific symptoms identified by the reviewer.
5. Feedback on findings from assessments, root-cause analyses, status of corrective actions and adherence to action plan schedules should be frequently provided to management.

135 Workplace Awareness

1. Management initiatives to facilitate the expression of concerns on the part of the work force, to address such concerns and to solve them are strongly encouraged to ensure the proper respect for and understanding of radiation.
2. A radiological awareness reports system should be established and supported by management. To enhance workforce 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 from long-lived radionuclides in the workplace present special challenges to a Radiological Control program and warrant particular attention. Due to the difficulty of measuring transuranic uptakes that result in low doses, specific actions are required to minimize the risks of internal exposure.

Administration of internal dose assessment is costly in dollars and worker time. Control and analysis of samples is also more complicated than the elements of external dosimetry.

In order to minimize internal exposures, managers should take deliberate actions to control contamination at the source and reduce Airborne Radioactivity, Contamination and High Contamination Areas. Work should be planned to avoid the routine use of respiratory protection devices. Internal exposures should be ALARA and the following should be considered:

- Workers may be exposed to unanticipated levels of elevated airborne radioactivity. Collecting representative airborne radioactivity samples and the time required for technicians or automated instruments 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 internal radionuclides are difficult to measure. Although some radionuclides, such as cesium and tritium, can be readily measured at levels that produce only a few mrem, some long-lived radionuclides, like plutonium, require years for accurate measurements of hundreds of mrem.
- Medical intervention, such as the administration of blocking and chelating agents, to mitigate internal deposition adds risks by introducing additional chemicals into the body.

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- Sampling of body excretions and whole-body or organ counting techniques encourages worker perceptions of internal exposure significance.
- Use of respiratory protection devices imposes additional physical stresses upon participating workers.

137 Neutron Exposures

Neutron exposures have the following characteristics, which require attention:

- The specific biological effects of neutrons are not as well understood as the effects of gammas.
- Neutron equivalent dose is more difficult to assess than gamma equivalent dose.

As a result, those sites and facilities with neutron radiation should focus particular attention on minimizing collective neutron dose through setting aggressive goals (Article 131).

138 ALARA Committee

The As Low As Reasonably Achievable (ALARA) process of reducing radiation exposures is a fundamental requirement of every radiological control program. There is considerable leeway in determining how far is reasonable. Reducing exposure is desirable because of the direct relation to the health and safety of workers and the public. Reducing radiation exposure improves the quality of the workplace and in the long run saves resources.

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. This committee may be part of a general safety or radiation safety committee whose functions include ALARA activities. The ALARA committee should make recommendations to management to improve progress toward minimizing radiation exposure and radiological releases.

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PART 4 TOC 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 effectively function, 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 should be 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 Manual to duplicate organizations but to use personnel in a more effective manner in workplace situations.
2. Radiological control personnel should monitor adherence to this Manual and be available to the facility line manager for radiological support to the work force. To effectively function in this capacity, they should receive their day-to-day priorities from facility managers. To ensure independence in making correct radiological decisions, the Radiological Control organization should be accountable to the Radiological Control Manager.

The contractor shall identify those key radiation protection positions critical to effective management of the radiological health and safety program consistent with the guidance in DOE-STD-1107-97 Table 1, reaffirmed June 2005, "Knowledge, Skills and Abilities for Key Radiation Protection Positions at DOE Facilities", or equivalent [HSD B.1].

The contractor shall ensure that individuals fulfilling key radiation protection positions identified above demonstrate technical competence and experience to establish, maintain, and implement their applicable functional areas of the radiological control program, and possess the management skills to direct radiological control programs within their range of responsibility [HSD B.2].

Personnel fulfilling key radiation protection positions shall be qualified in accordance with the criteria provided in Appendix A of DOE-STD-1107-97, reaffirmed June 2005, "Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities," or equivalent [HSD B.3].

3. The Radiological Control Manager heads the Radiological Control organization and is responsible for and should establish a high quality Radiological Control program. ***Staffing of the radiological health and safety organization shall be adequate to ensure safe operations [HSD B.4].***
4. The Radiological Control Manager should have access to the senior site executive for radiological control matters.
5. ***WRPS shall [835.103] identify individuals with the authority and responsibility to develop and/or implement WRPS radiological activities. Application of this requirement will utilize a graded approach for implementation, and will address education, training, and skills needed to discharge job responsibilities. Individuals can include technical and management personnel within the radiological control organization, independent assessors, and line managers responsible for radiological work activities. Training for these individuals is addressed in the WRPS training and qualification plan and implemented using the training management system. [RPP # 38]***

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These individuals include:

- *RC Technicians,*
- *First Line Rad Con managers,*
- *Rad Con technical staff,*
- *Rad Con Managers,*
- *RWP Preparers,*
- *Rad Work Planners,*
- *Managers (including lead workers) with the authority and responsibility for radiological work and/or program oversight,*
- *ALARA technical support personnel.*
- *Selected individuals will be trained as source custodians, containment installers and/or inspectors.*

142 Radiological Control Manager Qualifications

1. The Radiological Control Manager should be an experienced professional in radiological control and be familiar with the design features and operations of the facility that affect the potential for exposures of persons to radiation.
2. *The Radiological Control Manager shall [835.103] 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 [RPP # 38] [HSD B.2].*
3. The Radiological Controls 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-1107-97, "Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities."
4. In situations where 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.

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. Personnel should be provided continuing training to ensure that job proficiency is maintained. Pursuit of certification by the American Board of Health Physics for senior and professional staff members is encouraged.
2. Radiological support personnel provide health physics and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation and calibration functions. *These personnel shall [835.103 and 835.901] have technical qualifications pertinent to their assigned duties. [RPP # 38]*

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3. Appropriate standards for the education and training of radiological control organization senior staff and support personnel are provided in DOE-STD-1107-97, "Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities."

144 Relationship Between Health Physics Technicians and Workers

Health Physics Technicians and their supervisors perform the functions of assisting and guiding workers in the radiological aspects of the job.

1. Radiological workers should be sufficiently qualified to recognize questionable or deteriorating radiological conditions and seek advice from Health Physics Technicians and their supervisors.
2. Health Physics Technicians and their supervisor should have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution or test will result in imminent danger or unacceptable risk. Workers, through their supervisor, also have stop work authority 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 aspects of the job. Radiological control personnel are not present to compensate for poor management of the work force and should not be required to do so. A poorly trained work force should participate in an accelerated training initiative.

145 Marginal Radiological Control Performance

1. When radiological control performance is less than adequate, performance must be improved. Consideration should be given to strengthening line management and the Radiological Control organization to provide adequate radiological control.
2. In cases where 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. Initial actions should include:
 - a. More direct line supervision in the workspace
 - b. Curtailment of work schedules
 - c. Deferral of work
 - d. Addition of extra radiological control personnel
 - e. Conduct of additional training.
3. When the workers and supervisors achieve the proper level of radiological performance, the number of radiological control personnel should be reevaluated.

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PART 1 Administrative Control Levels and Dose Limits

The DOE's objective is to maintain personnel radiation exposure well below regulatory dose limits. To accomplish this objective, challenging numerical administrative control levels are established below the regulatory limits to administratively control and help reduce individual and collective radiation dose. In general, efforts to reduce individual dose should not be allowed to cause a concurrent increase in collective dose. These control levels are multi-tiered, with increasing levels of authority required to approve higher administrative control levels.

The committed effective dose is used to assign internal dose received by personnel at DOE facilities. The committed effective dose is the resulting dose committed to the whole body from internally deposited radionuclides over a 50-year period after intake. Unless otherwise indicated, administrative, lifetime and special control levels, and dose limits are stated in terms of the sum of the doses received from internal and external sources.

211 Administrative Control Levels

1. *A DOE-ORP maximum Administrative Control Level of 2,000 millirem per calendar year per individual is established for all DOE activities on the Hanford site. Approval by the ORP Site Manager shall be required prior to allowing an individual to exceed 2,000 millirem in a calendar year [HSD C.1].*
2. Tank Farms administrative control levels are shown in table 2-0.
3. No person should be allowed to go above the facility administrative control level(s) without the prior approvals as specified in Table 2-0.

Table 2-0, Tank Farms Administrative Control Levels

Maximum Equivalent Dose (Annual), millirem				
Whole Body (a)	Skin and Extremities (b)	Lens of Eye (c)	Any Organ or Tissue (d)	Approval Required to Exceed This Level (approvals are sequential)
500	15,000	4,500	15,000	Level 2 line manager & Project RadCon Manager
1,000	22,500	6,750	22,500	Level 1 line manager & TOC RadCon Manager
1,500	30,000	9,000	30,000	TOC Chief Operating Officer
2,000				DOE-ORP Site Manager
Age x 1,000 = lifetime total effective dose (TED)				Level 1 line manager & TOC RadCon Manager
(a) Whole Body Total Effective Dose (internal + external).				
(b) Skin and Extremities: Equivalent Dose to the skin or any extremity (external) + Committed Equivalent Dose to the skin or any extremity (internal).				
(c) Equivalent Dose to the lens of the eye.				
(d) Any organ or tissue (other than lens of the eye): Equivalent Dose to the whole body (external) + Committed Effective Dose (internal).				

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212 Lifetime Control Level

1. In order to administratively control a worker's lifetime occupational dose, a lifetime control level of N rem should be established where N is the age of the person in years. Special control levels (Article 216) should be established for personnel who have doses exceeding N rem.
2. ***Cumulative total effective dose shall [835.702(c)(5)(iii)] be recorded for all exposures received since January 1, 1989. [RPP # 172]*** The internal contribution to lifetime occupational dose should continue to be reassessed as further bioassay results and improved methods for assessing internal dose become available.
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. The committed effective dose should be used to the extent that adequate data are available to calculate doses in these terms.

213 Occupational Dose Limits

1. ***Occupational dose limits are provided in Table 2-1 and shall [835.202(a), 835.206(a), & 835.207] not be exceeded. Except for planned special exposures conducted consistent with Article 213.3 and emergency exposures authorized in accordance with Article 213.4, the occupational dose received by general employees shall [835.202(a)] be controlled such that the limits in Table 2-1 are not exceeded in a year. [RPP # 40-43 (all); 63 & 66 (1st sentence only)]***

All occupational doses received during the current year, except doses resulting from planned special exposures conducted in compliance with Article 213.3 and emergency exposures authorized in accordance with Article 213.4, shall [835.1(c), 835.202(b)] be included when demonstrating compliance with Table 2-1, occupational dose limits for general employees and minors. [RPP #10 & 44]

2. ***Radiological workers from other facilities may receive occupational exposure as a radiological worker if they: [RPP # 175]***
 - a. Provide record of current Radiological Worker I or II standardized core training
 - b. Receive site-specific Radiological Worker I or II training at the facilities where they will be working
 - c. ***Provide their radiation dose records for previous years and written estimates, signed by the individual, for the current year [835.702(d)]. [RPP # 175]***
3. The following provisions apply to planned special exposures:
 - 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 for general employees specified in Table 2-1, provided that each of the following conditions is satisfied: [RPP # 48]***

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- *The planned special exposure shall [835.204(a)(1)] be considered only in an exceptional situation when alternatives that might prevent a radiological worker from exceeding the limits in Table 2-1 are unavailable or impractical; [RPP # 48]*
 - *The contractor management (and employer, if the employer is not the contractor) specifically requests the planned special exposure, in writing [835.204(a)(2)]; [RPP # 49]*
 - The proposed activity has been reviewed by the TOC Radiological Control Manager and submitted specifically by the senior site executive to DOE-ORP; and
 - *Joint written approval shall [835.204(a)(3)] be received from the appropriate DOE Headquarters program office and the Secretarial Officer responsible for environment, safety and health matters. [RPP # 50]*
- 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 [835.204(b)] be determined. [RPP # 51]*
- c. An individual shall [835.204(c)] not receive a planned special exposure that, in addition to the doses determined in Article 213.3.b, would result in a dose exceeding the following:*
- *In a year, the numerical values of the dose limits established at Table 2-1 for general employees; and [RPP # 52]*
 - *Over the individual's lifetime, five times the numerical values of the dose limits established at Table 2-1 for general employees. [RPP # 53]*
- d. Prior to a planned special exposure, written consent shall [835.204(d)] be obtained from each individual involved. Each written consent shall [835.204(d)] include:*
- *The purpose of the planned operations and procedures to be used; [RPP # 54]*
 - *The estimated doses and associated potential risks and specific radiological conditions and other hazards which might be involved in performing the task; and [RPP # 55]*
 - *Instructions on the measures to be taken to keep the dose ALARA considering other risks that may be present. [RPP # 56]*
- e. Records of the conduct of a planned special exposure shall [835.204(e)] be maintained and a written report submitted within 30 days after the planned special exposure to the approving organizations identified in Article 213.3(a). [RPP # 57]*
- f. The dose from planned special exposures shall [835.204(f)] not to be considered in controlling future occupational dose of the individual under Table 2-1, but is to be included in records and reports required by 10 CFR 835. [RPP # 58]*

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4. The following provisions apply to emergency exposure situations:
- a. *A general employee whose occupational dose has exceeded the numerical value of any of the limits specified in Table 2-1 as a result of an authorized emergency exposure may be permitted to return to work in radiological areas during the current year providing that all of the following conditions are met [835.1301(a)]:*
 - *Approval is first obtained from the contractor management and the Head of the responsible DOE field organization (DOE-ORP Manager); [RPP # 245]*
 - *The individual receives counseling from radiological protection and medical personnel regarding the consequences of receiving additional occupational exposure during the year; and [RPP # 246]*
 - *The affected employee agrees to return to radiological work. [RPP # 247]*
 - b. *All doses exceeding the limits specified in Table 2-1 shall [835.1301(b)] be recorded in the affected individual's occupational dose record. [RPP # 248]*
 - c. *When the conditions under which a dose was received in excess of the limits specified in Table 2-1, except those received in accordance with the planned special exposure provisions in Article 213.3, have been eliminated, operating management shall [835.1301(c)] notify the Head of the responsible DOE field organization (DOE-ORP Manager). [RPP # 249]*
 - d. *Operations which have been suspended as a result of a dose in excess of the general employee occupational dose limits specified in Table 2-1, except those received in accordance with the planned special exposure provisions in Article 213.3, shall [835.1301(d)] be resumed only with the approval of DOE. [RPP # 250]*
 - e. Emergency exposure limits are not Planned Special Exposure limits. The following apply to emergency situations:
 - *The risk of injury to those individuals involved in rescue and recovery operations shall [835.1302(a)] be minimized. [RPP # 251]*
 - *Operating management shall [835.1302(b)] weigh actual and potential risks against the benefits to be gained. [RPP # 252]*
 - *No individual shall [835.1302(c)] be required to perform a rescue action that might involve substantial personal risk. [RPP # 253]*
 - See Article 656.7 for applicable training.
5. General employee dose limits are provided in Table 2-1. However, general employees who have not completed Radiological Worker I or II training are not permitted unescorted access to any area in which they are expected to receive doses in excess of 100 millirem in one year. General employees who have not received Radiological Worker I or II training are not normally expected to exceed 100 millirem in a year.

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Table 2-1, Summary of Dose Limits [10 CFR 835]

Exposures shall [10 CFR 835] be below the limits in this table and maintained As Low As Reasonably Achievable. The administrative control levels for limiting exposure are described in Article 211.

TYPE OF EXPOSURE	ANNUAL LIMIT
General Employee: Whole body total Effective Dose (internal + external)	5 rem
General Employee: Equivalent Dose to the lens of eye	15 rem
General Employee: Skin and extremities: Equivalent dose to the skin or any extremity (external) + Committed equivalent dose to the skin or any extremity (internal)	50 rem
General Employee: Any organ or tissue (other than lens of eye): Equivalent Dose to the whole body (external) + Committed Equivalent Dose (internal)	50 rem
Declared Pregnant Worker: Equivalent Dose to the embryo/fetus (internal + external)	0.5 rem per gestation period
Minors occupationally exposed: Whole body Total Effective Dose (internal + external)	0.1 rem
Minors occupationally exposed: Equivalent Dose to the lens of the eye, skin, and extremities	10% of General Employee Limits

NOTE:

- 1. Internal dose to the whole body shall [835.203(a)] be calculated as committed effective dose. The committed effective dose is the resulting dose committed to the whole body from internally deposited radionuclides over a 50-year period after intake. [RPP # 46] Determinations of the effective dose shall [835.203(b)] be made using the radiation and tissue weighting factor values provided in Appendix 2A. [RPP # 47]*
- 2. The annual limit of exposure 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 the equivalent dose to the whole body for external exposures [835.202(a)(2)]. [RPP # 41]*
- 3. Doses from background, therapeutic and diagnostic medical radiation, and participation as a subject in medical research programs shall [835.202(c)] not be included in dose records or in the assessment of compliance with the occupational dose limits. [RPP # 45]*
- 4. Non-uniform exposures of the skin from X-rays, beta radiation, and/or radioactive material on the skin shall [835.202(a)(4) & 835.205] be assessed as specified in Appendix 2B. [RPP #43 & 59]*
- 5. The total effective dose during a year shall [835.203(a)] be determined by summing the effective dose from external exposures and the committed effective dose from intakes during the year. [RPP # 46]*

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214 Member of the Public Dose Limit

The total effective dose limit for members of the public exposed to radiation and/or radioactive material during access to a controlled area shall [835.208] be 0.1 rem (0.001 Sv) in a year. [RPP # 67]

The total effective dose limit for minors exposed to radiation and/or radioactive material during access to a Radiologically Controlled Area is 0.1 rem in a year. DOE-ORP direction on radiation exposure to minors during access to the Hanford site requires compliance with the following:

1. ***Minors are prohibited access to Contamination Areas (CAs), High Contamination Areas (HCAs), Radiation Areas (RAs), High Radiation Areas (HRAs), Very High Radiation Areas (VHRAs), Airborne Radioactivity Areas (ARAs), and Soil Contamination Areas (SCAs). [HSD D.1.a]***
2. ***Minors are permitted access to Radiologically Controlled Areas (RCAs), Underground Radioactive Material Areas (URMAs), Radiological Buffer Areas (RBAs), and Radioactive Material Areas (RMAs) under the following conditions [HSD D.1.b]:***
 - a. ***The purpose for access to radiological areas is for education or contractor sponsored family days (e.g., tours of B Reactor, shadow days, “take your daughter/son to work” days.) [HSD D.1.b.1];***
 - b. ***Written consent (e.g., parental consent and hold harmless clause) is granted by parent/guardian and paperwork requiring the minor’s signature is also reviewed and signed by the parent/guardian [HSD D.1.b.2];***
 - c. ***Minors entering RBAs and RMAs have completed the required orientation for escorted access [HSD D.1.b.3];***
 - d. ***Minors are escorted by personnel trained in accordance with 10 CFR 835 and the HSD [HSD D.1.b.4];***
 - e. ***Hanford dosimeters are issued for entries to RBAs and RMAs to document radiation dose in accordance with individual contractor implementing procedures [HSD D.1.b.5];***
 - f. ***For entry into an RBA for contamination control, the facility will take action to stop work that could spread contamination to the RBA during the visit and verify the accessible portion of the RBA is uncontaminated prior to entry by the visitors [HSD D.1.b.6];***
 - g. ***Handling or touching radioactive material labeled or controlled per 10 CFR 835 by the minor is prohibited [HSD D.1.b.7];***
 - h. ***Access to RBAs and RMAs is prohibited in areas where exposure rates exceed 0.5 mrem/hr [HSD D.1.b.8].***

NOTE: Table 6-1 contains training requirements for unescorted personnel.

3. The TOC may impose more restrictive limitations on access by minors to the facilities they manage. Hanford contractors and DOE employees are required to comply with any additional limitations.

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4. Records of written consent of the parent/guardian will be maintained by the TOC.
5. Tours of Hanford facilities approved by DOE-ORP Office of External Affairs and affected DOE-ORP Line Assistant Manager that are open to access by minors, are required to meet the DOE-ORP policy on radiation exposure to minors and any more restrictive contractor imposed limitations on access by minors.

215 Embryo/Fetus Dose Limits

After a female worker voluntarily notifies her employer in writing that she is pregnant, for the purposes of fetal/embryo dose protection, she is considered a declared pregnant worker. ***Written declarations of pregnancy, including the estimated date of conception, and revocations of declarations of pregnancy shall [835.704(d)] be maintained. [RPP # 187]*** This declaration may be revoked, in writing, at any time by the 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 is unlikely.
2. ***For a declared pregnant worker who chooses to continue working as a radiological worker:***
 - a. ***The equivalent dose limit for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem (0.005 Sv) [835.206(a)]. [RPP # 63]***
 - b. ***Substantial variation above a uniform exposure rate that would satisfy the limits provided in Table 2-1 shall [835.206(b)] be avoided. [RPP # 64]*** Efforts should be made to avoid exceeding 50 millirem per month to the declared pregnant worker.
3. ***If the equivalent dose to the embryo/fetus is determined to have already exceeded 0.5 rem (0.005 Sv) by the time the worker declares her pregnancy, the declared pregnant worker shall [835.206(c)] not be assigned to tasks where additional occupational exposure is likely during the remaining gestation period. [RPP # 65]***

216 Special Control Levels

Certain situations require lower individualized exposure control levels. In addition to considering recommendations from senior radiological control and medical officials, the TOC senior site executive should obtain advice from professionals in other disciplines such as human resources and legal in establishing special control levels. The TOC 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 established for each monitored person with a lifetime occupational dose exceeding N rem, where N is the age of the person in years. The special control level should not exceed 1 rem and should allow the person's lifetime occupational dose to approach N rem as additional occupational exposure is received.
2. An employer should be attentive to special circumstances of employees, such as those undergoing radiation therapy, and establish special control levels as appropriate.

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3. Special controls on an individual's 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 TOC senior site executive should authorize any doses in excess of the special control level, but not to exceed the regulatory dose limits.

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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.

221 Personnel Contamination Control

1. *Individuals exiting Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas or Radiological Buffer Areas established for contamination control shall [835.1102(d)] be monitored, as appropriate, for the presence of surface contamination as required by Article 338. This does not apply to personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment. At such facilities, additional emphasis should be placed on worker bioassay programs and routine contamination and air sampling programs. [RPP # 233]*
2. *Monitoring for contamination shall [835.401(a)-(1), and 835.1102(d)] be performed using frisking equipment that can detect total contamination of at least the values specified in Table 2-2. DOE encourages the use of automatic monitoring units that meet the above requirements. [RPP # 70 & 233]*
3. Personnel 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 should be considered contaminated if either the removable or total radioactivity is detected above the levels in Table 2-2. *If an area cannot be decontaminated promptly, then it shall [835.603(e-f)] be posted as specified in Article 235. [RPP # 139 & 140] Any area in which contamination levels exceed the values specified in Table 2-2 shall [835.603(e), 835.1102(b)] be controlled in a manner commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable surface contamination levels. [RPP # 230]*
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 project Radiological Control Manager.
3. *Areas accessible to individuals where the measured total surface contamination levels exceed, but the removable surface contamination levels are less than, corresponding surface contamination values specified in Table 2-2, shall [835.1102(c)] be controlled as follows when located outside Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas:*
 - a. *The area shall [835.1102 (c)(1)] be routinely monitored to ensure the removable surface contamination level remains below the removable surface contamination values specified in Table 2-2. [RPP # 231]*

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- b. A formal inventory should be maintained of Fixed Contamination Areas.
 - c. ***The area shall [835.1102(c)(2)] be conspicuously marked to warn individuals of the contamination status. [RPP # 232]*** Markings should be kept legible. Markings should include the standard radiation warning trefoil in black or magenta imposed upon a yellow background, should be clearly visible from all directions and contrast with the colors of the surface coatings. Posting criteria are contained in Article 235.
 - d. Removable contamination should not exceed Table 2-2 values and should be reduced as far below Table 2-2 as is reasonably achievable before a fixative coating is applied.
 - e. Fixed contamination should be covered with two layers of fixative coatings having different colors.
 - f. Additional coating should be applied when the bottom color appears.
4. A Fixed Contamination Area may be located outside Controlled Areas unless unrestricted access is likely to result in a dose to any person greater than 100 millirem in a year.
 5. A Fixed Contamination Area is exempt from the general posting requirements of Article 231 and entry and exit requirements of Chapter 3.

223 Airborne Radioactivity Control Levels

1. ***The derived air concentration (DAC) values given in 10 CFR 835 Appendices A and C shall [835.209(a)] be used in the control of occupational exposures to airborne radioactive material. [RPP # 68]***
2. Personnel should not be exposed unnecessarily to airborne radioactivity. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing personnel, with or without respiratory protection, to enter areas with airborne radioactivity.
3. ***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 10 CFR 835; or 2) an individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week shall [835.603(d)] be posted as an Airborne Radioactivity Area. [RPP # 138]*** Occupied areas with airborne concentrations of radioactivity greater than or potentially greater than 20 percent of a DAC should be posted as an Airborne Radioactivity Area. For most radionuclides, air containing 20 percent of a DAC results in a committed effective dose of approximately 20 millirem if inhaled continuously for a 40-hour work week.

Where the TOC establishes a TED for not posting an area as an airborne radioactivity area for conditions greater than or potentially greater than a 20 percent of a DAC, but less than 1 DAC or 12 DAC-hours in a week, the TED should identify an alternative to posting that informs the workers of the airborne radioactivity hazard in the area (worker right to know). In these instances, with the exception of posting, all of the requirements of this Manual for monitoring and control of Airborne Radioactivity Areas, control of access to these areas, and monitoring of personnel should be

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implemented. *The contractor shall [835 App. A and C] comply with the contents of 10 CFR 835 Appendices A and C [835.App. A and C]. [RPP # 260-269]*

Table 2-2, Summary of Surface Contamination Values¹ in dpm/100 cm² [10 CFR 835]

Radionuclide	Removable ^{2,4}	Total (Fixed + Removable) ^{2,3}
U-nat, U-235, U-238, and associated decay products	71,000	75,000
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	N/A

¹ *The values in this table, 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 [835.Appendix D-1,]. [RPP # 271]*

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 [835.Appendix D-2,]. [RPP # 272]*

³ *The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm² is less than three times the value specified. For purposes of averaging, any square meter of surface shall [835, App. D, Note 3] 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 cm² area exceeds three times the applicable value. [RPP # 273]*

⁴ *The amount of removable radioactive material per 100 cm² 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 cm² is determined, the activity per unit area shall [835, App. D, Note 4] be based on the actual area and the entire surface shall [835, App. D, Note 4] 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 [835.Appendix D-4]. [RPP # 274]*

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 that has been separated from the other fission products or mixtures where the Sr-90 has been enriched [835.Appendix D-5,]. [RPP # 275]*

⁶ *Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall [835, App. D, Note 6] consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this table 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 cm² may be applicable either to metals, of the types which form insoluble special tritium compounds that have been exposed to tritium, or to bulk materials to which insoluble special tritium compound particles are fixed to a surface. In certain cases, a "Total" value of 10,000 dpm/100 cm² 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. [RPP # 276]*

⁷ *These limits only apply to the alpha emitters within the respective decay series [835.App. D, Note 7]. [RPP # 277]*

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PART 3 Posting

231 Posting Requirements

Each access point to radiological areas and radioactive material areas (as defined in the Glossary of this TFRCM) shall [835.603] be posted with conspicuous signs bearing the wording provided in this section. [RPP # 134] Criteria used for radiological posting and labeling shall be consistent between Hanford site contractors as members of the Hanford Radiological Control Forum [HSD E.1].

1. Radiological posting is used to alert personnel to the presence of radiation and radioactive materials and to aid them in minimizing exposures and preventing the spread of contamination. Boundaries used for radiological control purposes are illustrated in Figure 2-1. Tank Farms signs should conform to the specifications and examples of signs given in Appendix 2C to ensure consistency throughout Tank Farms. The addition of descriptive language to signs is allowed, provided that the signs are consistent in content, form, and style with the examples shown in Appendix 2C.
2. ***Signs shall [835.601(a)] contain the standard radiation symbol colored magenta or black on a yellow background. [RPP # 127]*** Lettering should be either magenta or black. Magenta is the preferred color over black. Standardized signs, as described in the standardized core training, should be used where practicable.
3. ***Signs shall [835.601(b)] be conspicuously posted, clearly worded, and, where appropriate, may include radiological control instructions. [RPP # 128]*** 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. Except as specified in this article, if more than one radiological condition (such as contamination and high radiation) exists in the same area, each condition should be identified.
7. Reserved.
8. Entrance points to areas of ongoing work activities controlled for radiological purposes should state basic entry requirements, such as dosimetry, Radiological Work Permit (RWP) and respirator required.
9. Rope, tape, chain, fence and similar barriers should be used to designate the boundaries of posted areas.
10. ***Physical barriers shall [835.501(c)(1), 835.601(b)] be placed so that they are clearly visible from all entry approaches. [RPP # 109 & 128]*** They should not be easily walked over or under, except at identified access points. ***These barriers shall [835.501(e)] be set up such that they do not impede the intended use of emergency exits or evacuation routes. [RPP # 116]***
11. Posting of doors should be such that the postings remain visible when doors are open or closed.

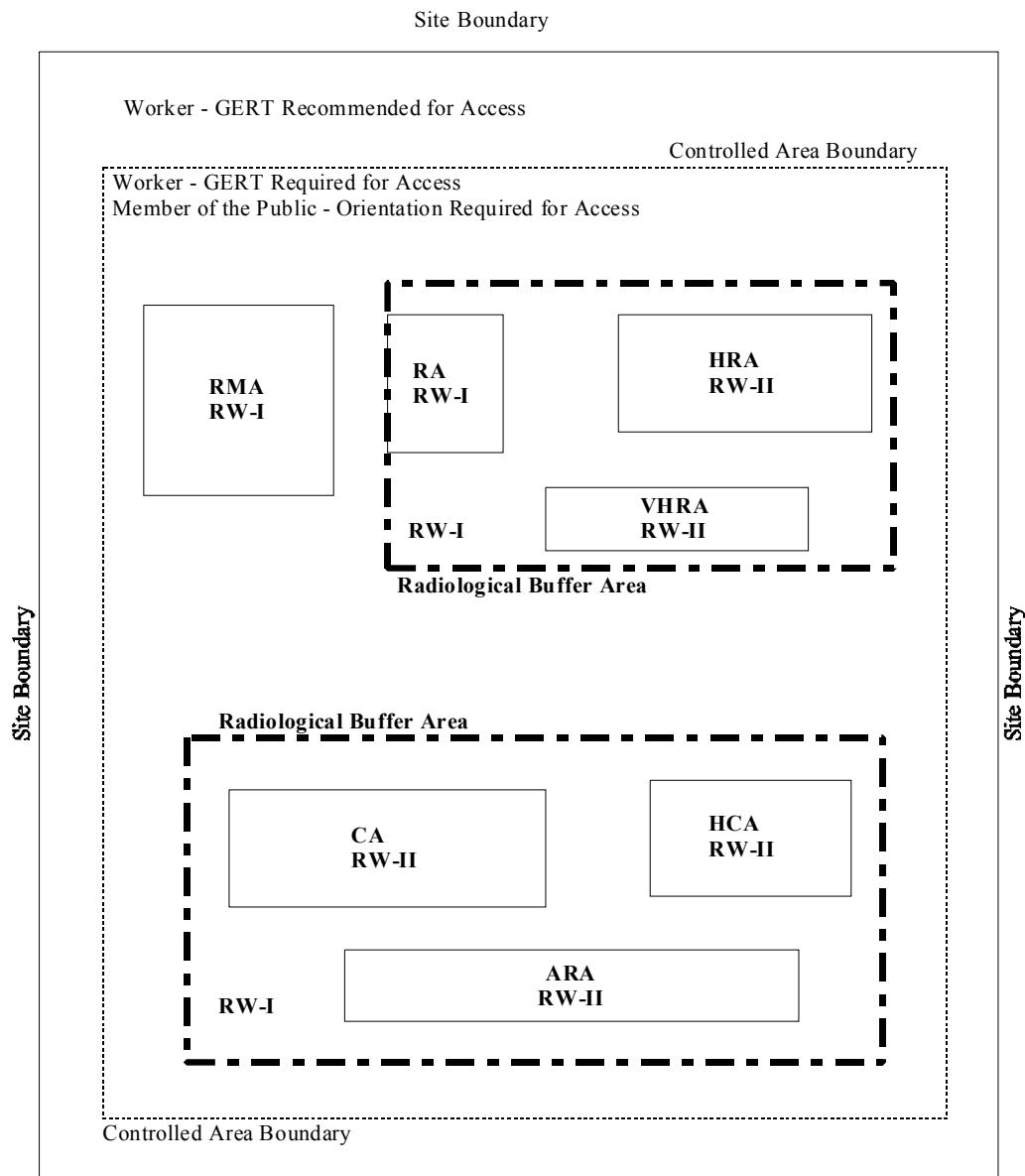
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12. A radiological posting that signifies the presence of an intermittent radiological condition should include a statement specifying when the radiation is present, such as “CAUTION: RADIATION AREA WHEN RED LIGHT IS ON.”
13. *The posting requirements in 10 CFR 835 may be modified to reflect the special considerations of DOE activities conducted at private residences or businesses [835.601(c)]. [RPP # 129] Such modifications shall [835.601(c)] provide the same level of protection to individuals as the existing provisions in 10 CFR 835. [RPP # 130]*
14. *Areas may be excepted from the posting requirements of 10 CFR 835 for periods of less than 8 continuous hours when placed under continuous observation and control of an individual knowledgeable of, and empowered to implement, required access and exposure control measures [835.604(a)]. [RPP # 142 & 143]*
15. Exceptions to posting of Radioactive Material Areas are contained in Article 236.
16. *Areas containing only packages received from radioactive material transportation labeled and in non-degraded condition need not be posted in accordance with Articles 234, 235, and 236, until the packages are monitored in accordance with Articles 423 [835.604(c)]. [RPP # 147]*

232 Posting Controlled Areas

1. *Each access point to a controlled area shall [835.602(a)] be posted whenever radiological areas or radioactive material areas exist in the area. [RPP # 131] Individuals who enter only controlled areas without entering radiological areas or radioactive material areas are not expected to receive a total effective dose of more than 0.1 rem in a year [835.602(a)]. [RPP # 132]* The identification of Controlled Area for Tank Farms was revised to Radiologically Controlled Area to more precisely identify the reason for which control is established. This terminology substitution applies to all instances where “Controlled Area” is used in this manual.
2. *The contractor may select the type of sign used [835.602(b)] to avoid conflict with local security requirements. [RPP # 133]*

Figure 2-1, Establish Posted Areas



GERT - General Employee Radiological Training	HRA - High Radiation Area
RW-I - Radiological Worker I	VHRA - Very High Radiation Area
RW-II - Radiological Worker II	CA - Contamination Area
RMA - Radioactive Material Area	HCA - High Contamination Area
RA - Radiation Area	ARA - Airborne Radioactivity Area

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233 Posting Radiological Buffer Areas

Radiological Buffer Areas should be established within the Controlled Area to provide secondary boundaries to minimize the spread of contamination and to limit doses to general employees who have not been trained as radiological workers. It is not expected that Radiological Buffer Areas will be established around inactive or secured Contamination Areas. The need for Radiological Buffer Areas in conjunction with Radioactive Material Areas should be evaluated.

1. The size of the Radiological Buffer Area should be commensurate with the potential for the spread of contamination outside Contamination, High Contamination and Airborne Radioactivity Areas. ***The contractor shall establish radiological buffer areas for contamination control adjacent to any entrance or exit from a contamination, high contamination, or airborne radioactivity area [HSD E.2].***
2. ***A Radiological Buffer Area is not required for High Contamination Areas or Airborne Radioactivity Areas that are completely within Contamination Areas, or for inactive Contamination, High Contamination, or Airborne Radioactivity Areas (i.e., areas to which entry has been prohibited by posting or barricades) [HSD E.2].***
3. A Radiological Buffer Area established to limit exposure to external radiation should surround Radiation, High Radiation and Very High Radiation Areas. ***The contractor shall establish radiological buffer areas for exposure control, as necessary, to limit whole body radiation doses to unmonitored individuals to less than 100 millirem per year [HSD E.3].*** Radiological Buffer Areas need not be posted for external exposure control if other posted boundaries provide equivalent employee protection.
4. Posting of Radiological Buffer Areas should be in accordance with Article 231 and should contain the wording "CAUTION, RADIOLOGICAL BUFFER AREA."

234 Posting Radiation Areas

1. ***Areas shall [835.603] be posted to alert personnel to the presence of external radiation in accordance with Table 2-3 and Article 231. [RPP # 135 -137]***
2. Dose rate measurements used to determine criteria for Radiation Areas should be made at a distance of 30 centimeters from the radiation source or from any surface through which the radiation penetrates. For Very High Radiation Areas, the measurement should be made at 1 meter.
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

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1 rem/hr. However, the locations of such hot spots should be noted on area surveys and discussed in pre-job briefings.

5. The requirement for personnel dosimetry should be included on the sign.
6. The requirement for an RWP should be included either on or in conjunction with the posting.
7. ***Dose that an individual could receive in an hour may be used as the criterion for posting; (Column 2 of Table 2-3) [835.603(a)]. [RPP # 135] The unit “rad” is associated with dose rates that pose an immediate danger [835.603(b-c)]. [RPP # 136 & 137]***

Table 2-3, Criteria for Posting Radiation Areas

AREA	DOSE RATE CRITERIA	POSTING
Radiation Area	> 0.005 rem/hr and ≤ 0.1 rem/hr at 30 cm.	“CAUTION, RADIATION AREA” “Personnel Dosimeter Required for Entry”
High Radiation Area	> 0.1 rem/hr at 30 cm and ≤ 500 rad/hr at 100 cm.	“DANGER, HIGH RADIATION AREA” “Personnel Dosimeter, Supplemental Dosimeter and RWP Required for Entry”*
Very High Radiation Area	> 500 rad/hr at 100 cm.	“GRAVE DANGER, VERY HIGH RADIATION AREA” “SPECIAL CONTROLS REQUIRED FOR ENTRY”*
Hot Spot (not in 10 CFR 835)	5 times general area dose rate and > 0.1 rem/hr	“CAUTION, HOT SPOT”

* 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 [835.603(d-f)] be posted to alert personnel to contamination in accordance with Table 2-4 and Article 231. [RPP # 138-140]***
2. The requirement for an RWP should be included either on or in conjunction with each posting as applicable.

Table 2-4, Criteria for Posting CAs, HCAs and ARAs

AREA	CRITERIA	POSTING
Contamination	Removable Contamination levels (dpm/100 cm ²) > 1 time but ≤ 100 times Table 2-2 values	“CAUTION, CONTAMINATION AREA”
High Contamination	Removable Contamination levels (dpm/100 cm ²) > 100 times Table 2-2 values	“DANGER, HIGH CONTAMINATION AREA” “RWP Required for Entry”
Fixed Contamination (not in 10 CFR 835)	Removable contamination levels < Table 2-2 removable values and total contamination levels > Table 2-2 total values	“CAUTION, FIXED CONTAMINATION”
Soil Contamination (not in 10 CFR 835)	Transferable contamination levels < Table 2-2 removable values and total contamination levels > Table 2-2 total values	“CAUTION, SOIL CONTAMINATION AREA”
Airborne Radioactivity	1 DAC or 12 DAC-hours/week	“CAUTION, AIRBORNE RADIOACTIVITY AREA” “RWP Required for Entry”

NOTE: Occupied areas with airborne concentrations of radioactivity greater than or potentially greater than 20 percent of a DAC should be posted and controlled in accordance with Article 223.3.

3. Derived Air Concentration (DAC) values for use with Table 2-4 are found in 10 CFR 835.
4. Areas meeting the criteria for Fixed Contamination Areas specified in Table 2-4 and Article 222.3 do not have to be posted as Contamination or High Contamination Areas.

236 Posting Radioactive Material Areas

1. *The words “Caution, Radioactive Material(s)” shall [835.603(g)] be posted at each radioactive material area. [RPP # 141]*
2. The requirement for personnel dosimetry should be included on the sign.
3. *Radioactive Material Areas shall [835(2)a] be located within Controlled Areas [RPP #13].*
4. *Areas may be excepted from the radioactive material area posting when [835.604(b)]:*
 - a. *Posted as a radiological area; or [RPP # 144]*
 - b. *Each item or container of radioactive material is labeled in accordance with the TFRCM such that individuals entering the area are made aware of the hazard; or [RPP # 145]*
 - c. *The radioactive material of concern consists solely of structures or installed components which have been activated (i.e., such as being exposed to neutron radiation or particles produced by an accelerator). [RPP # 146]*

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5. The definition of radioactive material and the requirements for labeling radioactive material are contained in Chapter 4.

237 Posting Underground Radioactive Material Areas

1. *The contractor shall establish soil contamination areas or underground radioactive material areas, as appropriate, for outdoor areas with known or suspect soil contamination or underground radioactive material [HSD E.4].*
2. Underground Radioactive Material Areas should be posted “UNDERGROUND RADIOACTIVE MATERIAL.” Posting should include instructions or special warnings to workers such as “Consult With 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 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. When access is likely to result in individual doses greater than 100 millirem in a year, entry requirements in Article 332.1 should be implemented.
5. *The Contractor shall ensure that any area within a soil contamination area or underground radioactive material area, in which an intrusive activity is performed, is posted as either a Radiological Buffer Area or a Contamination Area [HSD E.6].*
6. *The contractor shall ensure that members of the public shall not perform any intrusive activities within a URMA [HSD E.8].*
7. *URMAs are exempt from the URMA posting requirements if all of the following are met:*
 - *The area meets the definition of a URMA as defined in the Glossary,*
 - *No accessible radiological hazards exist that would require other radiological posting,*
 - *The area has been released under an interim or final approved Record of Decision, and*
 - *Appropriate institutional controls have been established for the area such as:*
 - *Specific controls included in the ROD are in place, and the size, location and boundaries of the area are documented, maintained, and accessible [HSD E.7].*

238 Posting Soil Contamination Areas

1. *The contractor shall establish soil contamination areas or underground radioactive material areas, as appropriate, for outdoor areas with known or suspect soil contamination or underground radioactive material [HSD E.4].*

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2. *If appropriate, direct or indirect measurement demonstrates that there is no radioactive contamination within the top 15 cm of soil for an area in which a direct contamination readings (above background) of the soil surface exceeds the appropriate “total” contamination levels in Appendix D, 10 CFR 835, then the area need not be posted or controlled as a SCA [HSD E.5.b].*
3. *An area, which would otherwise be classified as a SCA, need not be posted and controlled as a SCA if the area is covered by a layer of impervious material, e.g., asphalt, concrete, but shall be posted at a minimum URMA [HSD E.5.c].*
4. *The contractor shall ensure that postings of soil contamination areas contain 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. *Any area in which the transferable contamination exceeds the appropriate “removable” levels in Appendix D, 10 CFR 835, shall be posted and controlled as either a contamination or high contamination area in accordance with the provisions of 10 CFR 835. Note, changes in environmental conditions can affect the transferability of the contamination. [HSD E.5.a].*
5. *The contractor shall ensure that any area within a soil contamination area or underground radioactive material area, in which an intrusive activity is performed, is posted as either a Radiological Buffer Area or a Contamination Area [HSD E.6].*
6. The SCAs may be located outside Controlled Areas unless access is likely to result in unmonitored individuals receiving greater than 100 mrem/yr from the SCA.
7. The SCAs are exempt from the entry and exit requirements of Chapter 3 when access is not likely to result in individual doses greater than 100 mrem in a year. When access is likely to result in individual doses greater than 100 mrem in a year, entry requirements in Article 332.1 should be implemented. The posting should meet requirements of Article 231.1 through 231.8.

239 Internally and Potentially Internally Contaminated Systems.

1. At the discretion of the Project/Activity Radiological Control Manager, signs may be posted at the entrances to buildings, rooms, or areas informing individuals that an area contains internally and/or potentially internally contaminated systems.

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Appendix 2A, Tissue Weighting Factors [10 CFR 835]

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

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 ($H_{\text{remainder}}$), 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.

²For 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.

Appendix 2B, Non-Uniform Exposure of the Skin

Non-uniform exposures of the skin from x-rays, beta radiation and/or radioactive materials on the skin, including hot particles shall, [835.202(a)(4), 835.205] be assessed and recorded as specified in the table below: [RPP # 59]

AREA OF SKIN IRRADIATED	METHOD OF AVERAGING, ADDING TO OTHER DOSES RECEIVED, AND RECORDING NON-UNIFORM SKIN DOSE
≥ 100 cm ²	<i>The non-uniform equivalent dose received during the year shall [835.205(b)(1)] be averaged over the 100 cm² of the skin receiving the maximum dose, added to any uniform equivalent dose also received by the skin, and recorded as the equivalent dose to any extremity or skin for the year. [RPP # 60]</i>
≥ 10 cm ² and < 100 cm ²	<i>The non-uniform equivalent dose (H) to the irradiated area received during the year shall be added to any uniform equivalent dose also received by the skin and recorded as the equivalent dose to any extremity or skin for the year. H is the equivalent dose averaged over the 1 cm² of skin receiving the maximum absorbed dose, D, reduced by the fraction, f, which is the irradiated area in cm² divided by 100 cm² (i.e., H= fD). In no case shall [835.205(b)(2)] a value of f less than 0.1 be used. [RPP # 61]</i>
< 10 cm ²	<i>The non-uniform equivalent dose shall [835.205(b)(3)] be averaged over the 1 cm² of skin receiving the maximum dose. This equivalent dose shall [835.205(b)(3)]:</i> <ol style="list-style-type: none"> <li><i>a. Be recorded in the individual's occupational exposure history as a special entry; and</i> <li><i>b. Not be added to any other equivalent dose to any extremity or skin for the year. [RPP # 62]</i>

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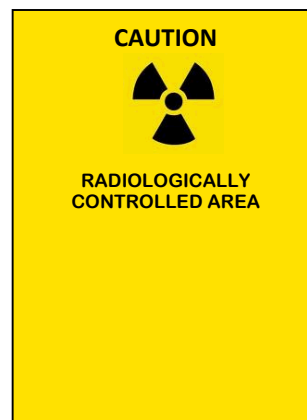
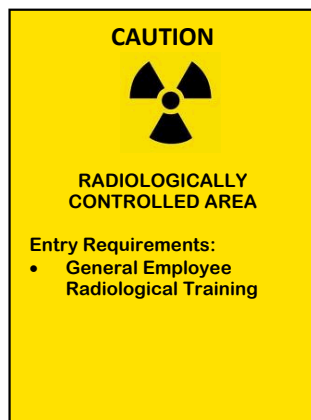
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Appendix 2C, Signs

General

- All lettering is to be black or magenta.
- All signs must have a yellow background.
- Radiation symbol magenta (preferred) or black.

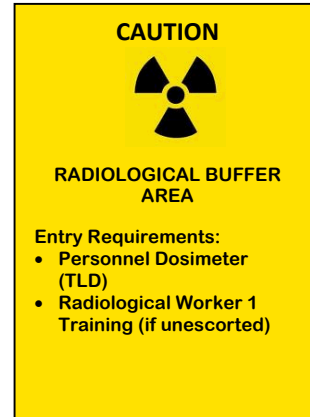
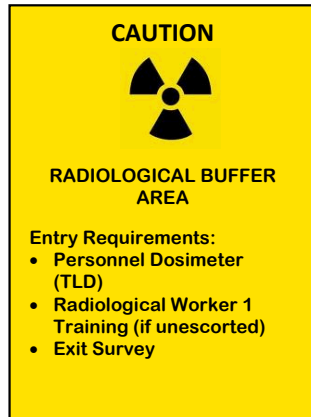
1. Radiologically Controlled Area



2. Radiological Buffer Area

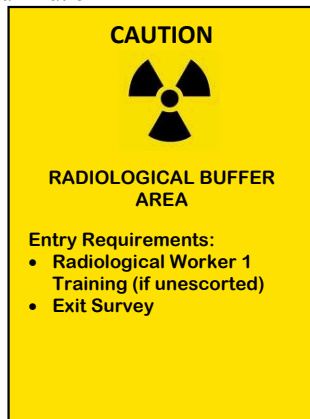
Note: For use when area is controlled for radiation and contamination

Note: For use when area is controlled for radiation

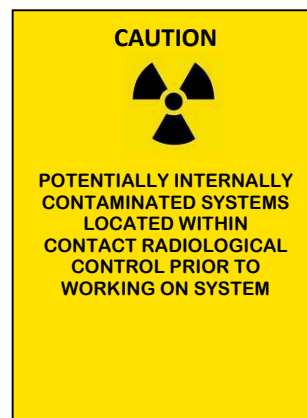
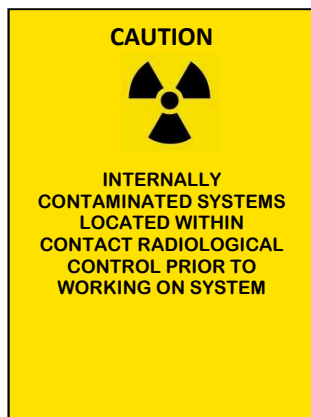


Radiological Buffer Area

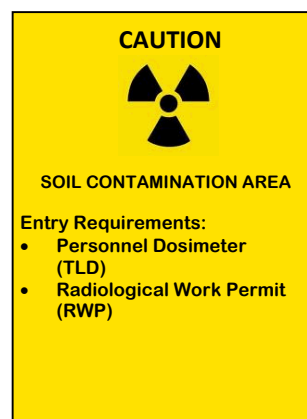
Note: For use when area is controlled for contamination



3. Internally Contaminated/Potentially Contaminated Systems



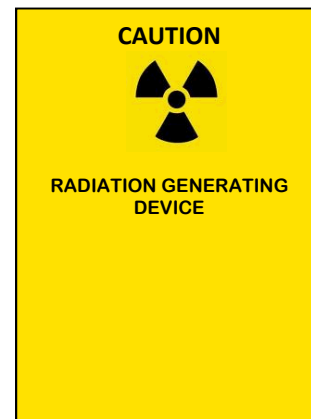
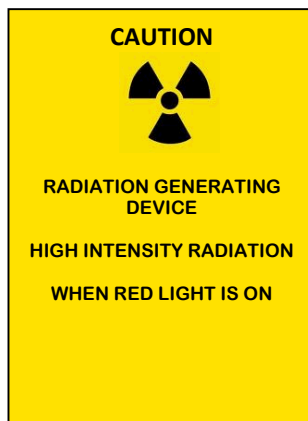
4. Soil Contamination Area

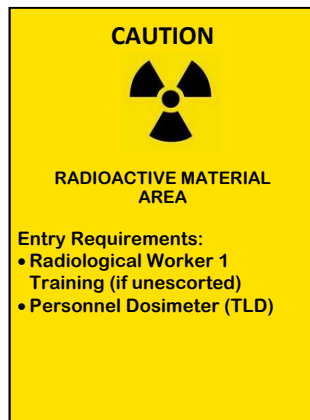
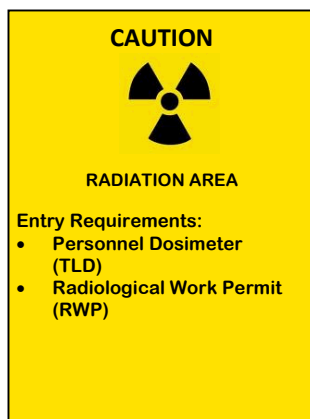
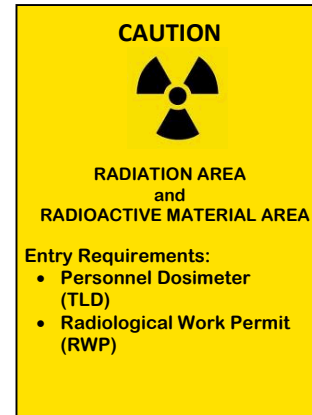


5. Underground Radioactive Material Area

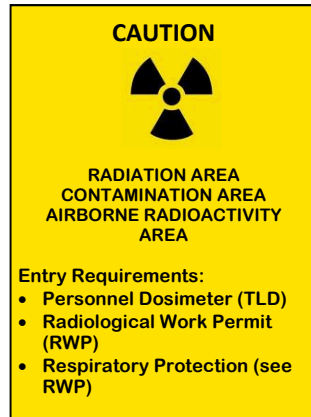


6. Radiation Generating Device

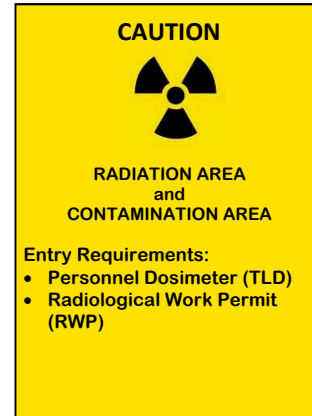


7. Radioactive Material Area**8. Radiation Area****9. Radiation Area and Radioactive Material Area**

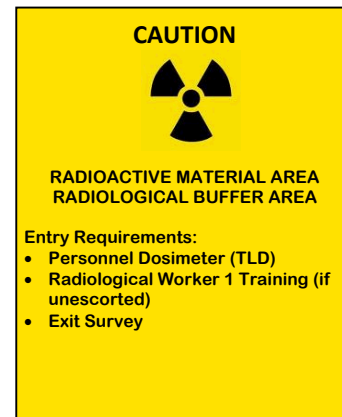
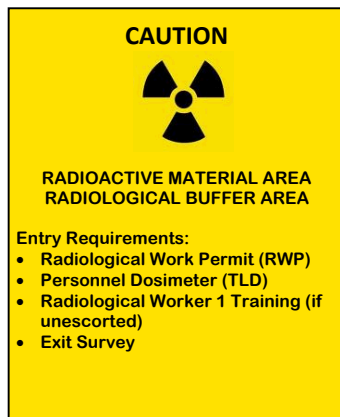
**10. Radiation Area, Contamination Area,
Airborne Radioactivity Area**



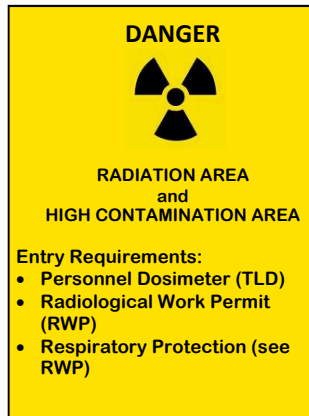
11. Radiation Area and Contamination Area



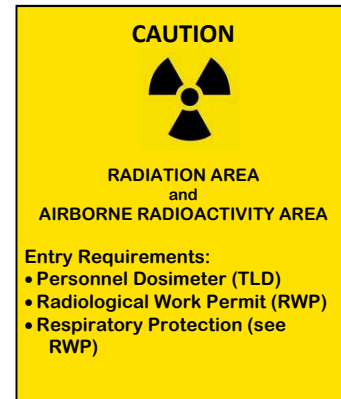
**12. Radioactive Material Area/Radiological
Buffer Area**



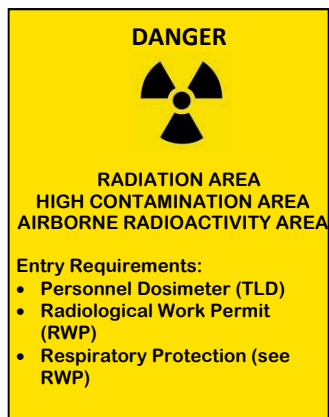
13. Radiation Area and High Contamination Area



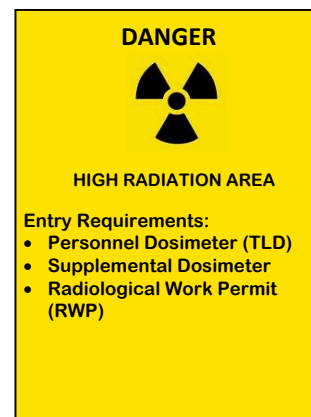
14. Radiation Area and Airborne Radioactivity Area

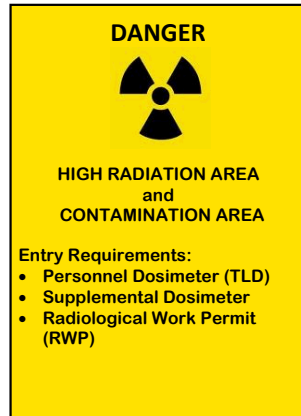
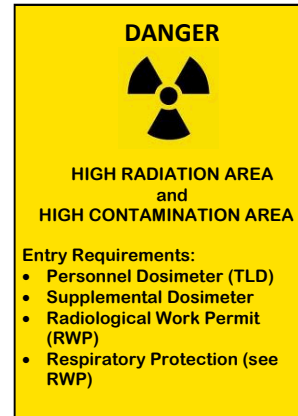
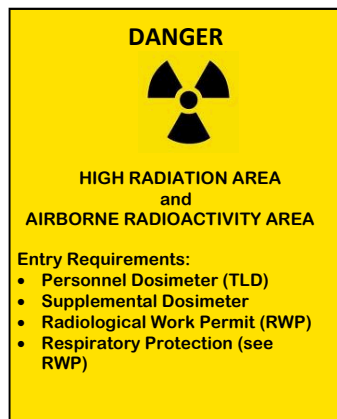
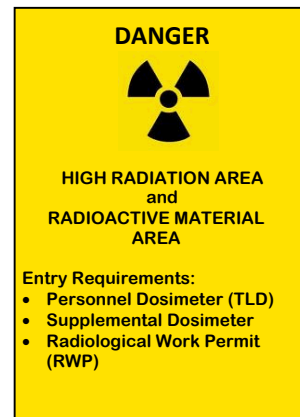


15. Radiation Area, High Contamination Area, Airborne Radioactivity Area



16. High Radiation Area



17. High Radiation Area and Contamination Area**18. High Radiation Area and High Contamination Area****19. High Radiation Area and Airborne Radioactivity Area****20. High Radiation Area and Radioactive Material Area**

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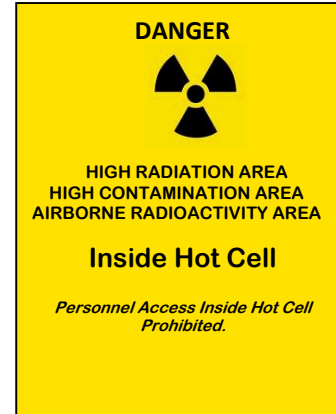
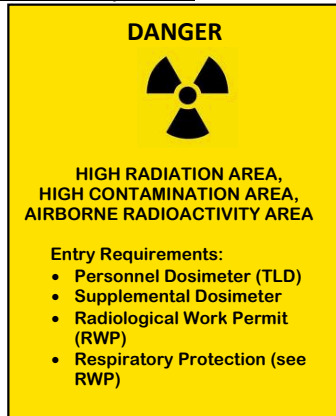
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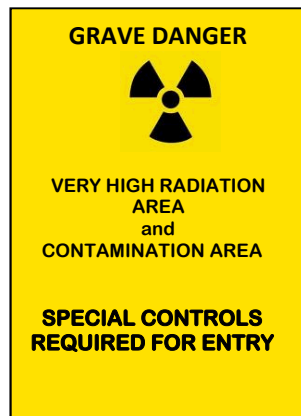
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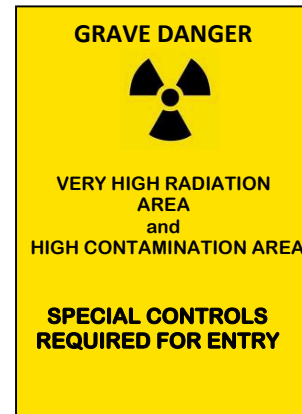
21. High Radiation Area, High Contamination Area, Airborne Radioactivity Area

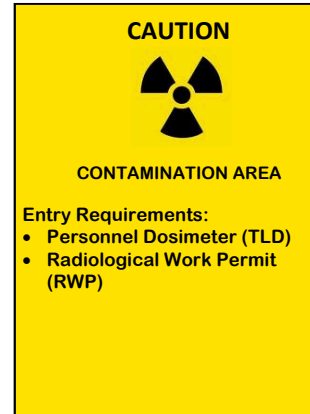
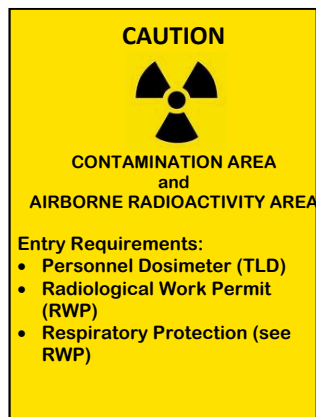
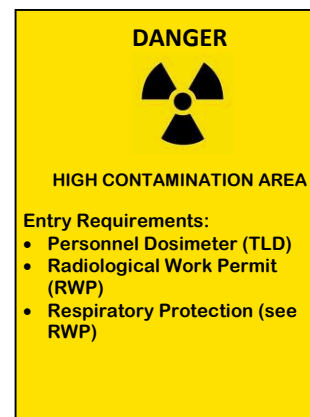


22. Very High Radiation Area and Contamination Area

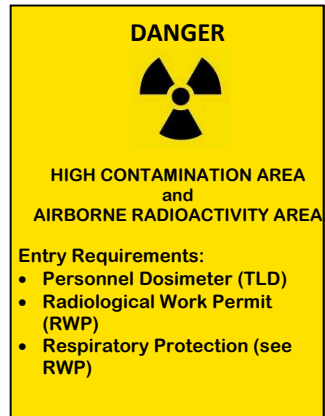


23. Very High Radiation Area and High Contamination Area

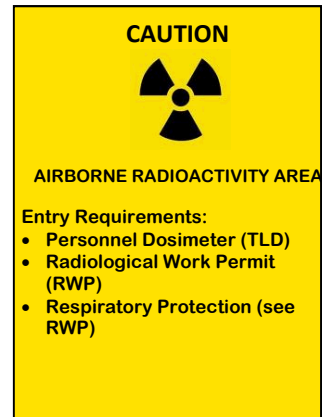


**24. Very High Radiation Area and
Radioactive Material Area****25. Contamination Area****26. Contamination Area and Airborne
Radioactivity Area****27. High Contamination Area**

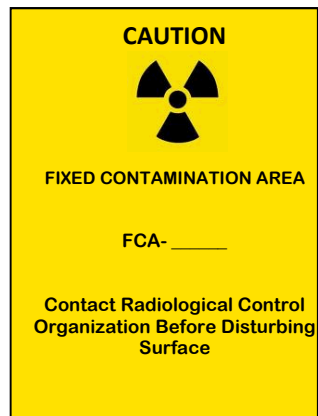
28. High Contamination Area and Airborne Radioactivity Area



29. Airborne Radioactivity Area



30. Fixed Contamination Area



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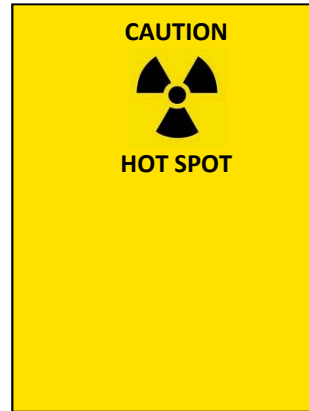
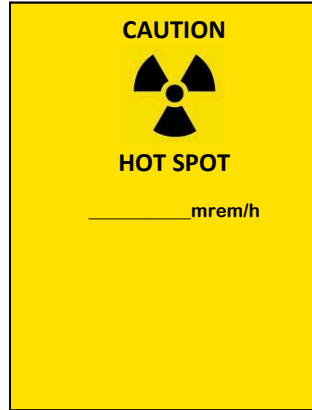
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31. Hot Spot



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CONDUCT OF RADIOLOGICAL WORK
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PART 1 Planning Radiological Work

311 Requirements

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. *Measures shall [835.1001(a)] be taken to maintain radiation exposure in controlled areas ALARA through engineered and administrative controls. [RPP # 212] During routine operations, the combination of engineered and administrative control shall [835.1003(a-b)] provide that: 1) the anticipated occupational dose to general employees shall [835.1003(a)] not exceed the limits established in Table 2-1, and 2) the ALARA process is utilized for personnel exposures to ionizing radiation [835.1003(b)]. [RPP # 222 & 223]*

The primary methods used to maintain exposures ALARA shall [835.1001(a)] be engineered controls (e.g., confinement, ventilation, remote handling, and shielding). [RPP # 213] Administrative controls shall [835.1001(a)] be employed only as supplemental methods to control radiation exposure. [RPP # 214] For specific activities where use of engineered controls is demonstrated to be impractical, administrative controls shall (835.1001(b)) be used to maintain radiation exposures ALARA [RPP # 215]. To accomplish this, the design and planning processes should incorporate radiological considerations in the early planning stages. The checklist in Appendix 3A is helpful in reducing occupational radiation exposure.

312 Planning for Maintenance, Operations and Modifications

1. Maintenance and modification plans and procedures should be reviewed to identify and incorporate radiological requirements, such as engineering controls and dose and contamination reduction considerations. Performance of this review is the responsibility of line management, with support and concurrence from the Radiological Control organization.
2. For routine tasks, such as surveillance, tours and minor non-radiological maintenance, performance of the above review and documentation of identified radiological requirements may be conducted as part of the Radiological Work Permit process (see Article 321).
3. This Manual establishes trigger levels requiring formal radiological review of non-routine or complex work activities. These trigger levels include:
 - a. Estimated individual dose of greater than 250 millirem or collective dose for a task projected to exceed 1 person-rem
 - b. Predicted airborne radioactivity concentrations in excess of 0.20 times the applicable DAC
 - c. Work area removable contamination greater than 100 times the values in Table 2-2 in the general area or in the work area
 - d. Entry into areas where whole body dose rates exceed 1 rem/h in a work area.
4. Tasks with the potential to exceed the above trigger levels should undergo a formal, documented radiological or ALARA review. At a minimum, this review should consider the following:

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- 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. Walk-down 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.
5. Radiological requirements identified as part of the above radiological review should be documented in the job plans, procedures or work packages.
 6. Optimization techniques, including cost-benefit analysis, represent a fundamental part of radiological design analysis and work review. Requirements for facility design and modification are contained in Article 128. 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.

313 Infrequent or First Time Activities

At those facilities with routine, recurring process operations, special management attention should be directed to radiological activities that are infrequently conducted or represent first-time operations. Planning for such activities should include:

1. Formal radiological review in accordance with Article 312.4;

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2. Senior management review directed toward anticipation of concerns and emphasis and specification of protective measures;
3. Review and approval by the Joint Review Group; and
4. Enhanced line and Radiological Control management oversight during the initiation and conduct of the work.

314 Temporary Shielding

1. The installation, use and removal of temporary shielding should be controlled by 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.
3. Installed temporary shielding should be periodically inspected and surveyed to verify effectiveness and integrity.
4. Radiation surveys should be performed during the alteration or removal of installed temporary shielding.
5. Installed temporary shielding should be visibly marked or labeled with the following or equivalent wording: "Temporary Shielding - Do Not Remove Without Permission from Radiological Control."
6. Installed temporary shielding should be periodically evaluated to assess the need for its removal or replacement with permanent shielding.
7. The requirements in this article apply to temporary shielding utilized for gamma and neutron radiation. Site procedures may identify specific shielding applications that fall outside the requirements 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. Technical work documents are not required for incidental or routine work activities that involve a low potential for worker exposure or workplace contamination, such as the collection of trash or used protective clothing.
2. Technical work documents used to control radiological work activities should be reviewed and approved by the Radiological Control organization.
3. Radiological control hold points should be incorporated into technical work documents for steps that require action by the Radiological Control organization to prevent radiation exposures in excess of administrative control levels, high airborne radioactivity concentrations, or the release of radioactivity to the environment.

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316 Minimization of Internal Exposure

The minimization and control of internal exposure as discussed in Article 136 should be conducted in accordance with the following hierarchy of controls:

1. ***Engineering controls, including containment of radioactive material at the source wherever practicable, shall [835.1002(c)] be the primary method of minimizing airborne radioactivity and internal exposure to workers. [RPP # 220]***
2. ***For specific activities where use of engineered controls is demonstrated to be impractical, administrative controls shall [835.1001(b)] be used to maintain radiation exposures ALARA. [RPP # 215]***
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 areas with airborne radioactivity levels exceeding or potentially exceeding 0.2 DAC;
 - b. During breach of contaminated systems or components;
 - c. Work in areas or on equipment with removable contamination levels greater than 100 times the values in Table 2-2; or
 - 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.
5. In specific situations the use of respiratory protection may be contraindicated due to physical limitations or the potential for significantly increased external exposure. In such situations, written authorization should be obtained from the line organization manager and the Radiological Control Manager prior to incurring internal exposure. Specific justification of the need to accept the exposure, including a description of measures taken to mitigate the airborne radioactivity, should be documented as part of the authorization process.
6. The following controls are applicable for 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.

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PART 2 Work Preparation

321 Radiological Work Permits

Written authorizations shall [835.501(d)] be required to control entry into and perform work within radiological areas. [RPP # 114] These authorizations shall [835.501(d)] specify radiation protection measures commensurate with the existing and potential hazards. [RPP # 115] The Radiological Work Permit (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, at a minimum, include the following information:
 - a. Description of work;
 - b. Initial and anticipated work area radiological conditions;
 - c. Dosimetry requirements;
 - d. Pre-job briefing requirements, as applicable;
 - e. Radiological 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 void the RWP;
 - i. Exposure control and reduction requirements;
 - j. Contamination control and reduction requirements;
 - k. Special personnel frisking considerations;
 - l. Technical work document number, as applicable;
 - m. Unique identifying number;
 - n. Date of issue and expiration;
 - o. Authorizing signatures; and
 - p. Entry control requirements.
2. 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.

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3. 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.

322 Use of Radiological Work Permits

1. RWPs should be used to control the following activities:
 - a. Entry into High and Very High Radiation Areas;
 - b. Entry into High Contamination Areas;
 - c. Entry into areas with airborne radioactivity levels exceeding or potentially exceeding 0.2 DAC;
 - d. Entry into Radiation Areas;
 - e. Entry into Contamination Areas; or
 - f. Handling of materials with removable contamination that exceed the values of Table 2-2.
 - g. When using HEPA-filtered vacuum cleaners to perform radiological work (see Article 464).
2. RWPs should be used to control radiological work activities. RWPs should not be approved for periods longer than one calendar year.
3. Reserved.
4. Radiological surveys should be routinely reviewed to evaluate adequacy of RWP requirements. RWPs should be updated if radiological conditions change to the extent that protective requirements need modification.
5. RWPs should be available at Radiological Access Control station used to sign onto the applicable radiological work permit.
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 any revisions to the RWP.
7. Worker pocket or electronic dosimeter readings should be recorded in a format that identifies and provides linkage to the applicable RWP.
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 requirements of this Article and Articles 321 and 323.

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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.
2. RWPs should be reviewed and approved by the Radiological Control organization.
3. The RWP should be based on current radiological surveys and anticipated radiological conditions.
4. The RWP should be approved by the supervisor responsible for the work or area and the appropriate Radiological Control supervisor. Revisions or extensions to RWPs should be subject to the same approval process.

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.
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. Radiological 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; and
 - i. Emergency response provisions.
3. Pre-job briefings should be conducted by the cognizant work supervisor.
4. Workers and supervisors directly participating in the job, cognizant Radiological Control personnel and representatives from involved support organizations should attend the briefing. Personnel who may be assigned to the job after the pre-job briefing has been completed should receive an equivalent documented briefing from the cognizant work supervisor prior to starting work.
5. A summary of topics discussed and attendance at the pre-job briefing should be documented. This documentation should be maintained with the technical work document.

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325 Personal Protective Equipment and Clothing

1. *Individuals shall [835.1102(e)] wear protective clothing during the following activities:*
 - a. *Handling of contaminated materials with removable contamination in excess of Table 2-2 levels;*
 - b. *Entry to areas in which removable contamination exists at levels exceeding the removable surface contamination values specified in Table 2-2. [RPP # 234]*

Individuals should wear protective clothing as directed by the Radiological Control organization or as required by the RWP.

2. Protective clothing and shoes designated for radiological control should be:
 - a. Marked in accordance with Article 461;
 - b. Used only for radiological control purposes.
3. Protective clothing dress-out areas should be established directly adjacent to the work area. Workers should proceed directly to the radiological work area after donning personal protective equipment and clothing.
4. Personal protective equipment and clothing should be selected as prescribed by the controlling RWP. General guidelines for protective clothing selection and use are provided in Appendix 3C.
5. The use of lab coats 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. Lab coats should not be used as protective clothing for performing physical work activities in Contamination, High Contamination or Airborne Radioactivity Areas.
6. Instructions for donning and removing protective clothing should be posted at the dress-out and step-off pad areas.
7. Reserved.
8. Company-issued clothing, such as work coveralls and shoes, should be considered the same as personal clothing. Company-issued clothing should not be used for radiological control purposes.

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Table 3-1, Guidelines for Selecting Radiological Personnel Protective Clothing (PPE)

CONDITIONS	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)
DRY	Full set of PPE ¹	Full set of PPE ¹	Double set of PPE ¹ , double gloves, double shoecovers.
WET	Full set of non- permeable PPE ²	Full set of non- permeable PPE ²	Double set of PPE ² with the outer pair being non-permeable; double gloves, double shoecovers.

1. Full set of PPE means for the portion of the body that enters the Radiological Area posted for contamination control, (e.g., arm sleeve and gloves for the hands and forearms crossing a contamination control boundary would be considered a full set of PPE for the portion of the body entering that contamination control boundary)
2. Full set of non-permeable PPE means for the portion of the body that enters the Radiological Area posted for contamination control and for the portions of the body that have the potential to have liquids sprayed and or wicked on to them.

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PART 3 Entry and Exit Requirements

330 General Requirements

The following are general requirements for an entry control program:

- 1. Personnel entry control shall [835.501(a)] be maintained for each radiological area. [RPP # 107]*
- 2. The degree of control shall [835.501(b)] be commensurate with existing and potential radiological hazards within the area. [RPP # 108]*
- 3. One or more of the following methods shall [835.501(c)] be used to ensure control:*
 - a. Signs and barricades; [RPP # 109]*
 - b. Control devices on entrances; [RPP # 110]*
 - c. Conspicuous visual and/or audible alarms; [RPP # 111]*
 - d. Locked entrance ways; or [RPP # 112]*
 - e. Administrative controls. [RPP # 113]*
4. Written authorizations should be required to control entry into and perform work within radiological areas. These authorizations should specify radiation protection measures commensurate with the existing and potential hazards.
- 5. No control(s) shall [835.501(e)] be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions. [RPP # 116]*
- 6. Appropriate controls shall [835.1102] be maintained and verified which prevent the inadvertent transfer of removable contamination to locations outside radiological areas under normal operating conditions. [RPP # 229]*
- 7. The contractor shall ensure that individuals meet the applicable minimum radiation safety training requirements in Table 3-1 for access to areas requiring control for radiological health and safety [HSD I.4].*

331 Controlled Areas

The Hanford Radiological Control Forum shall exercise paragraph 10 CFR 835.901(d) to the fullest extent, including the utilization of escorts for access to Radiological Controlled Areas or Radiological Areas for short duration visits by non-Hanford Individuals in lieu of training [HSD I.7]. Table 3-3 summarizes requirements for General Employee unescorted access.

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332 Radiological Buffer Areas

1. Minimum requirements for entry into Radiological Buffer Areas should include the following:
 - a. Radiological Worker I training (unescorted), GERT (with qualified escort)
 - b. Personnel dosimetry, as appropriate.
2. Personnel who exit a Radiological Buffer Area containing Contamination Areas, High Contamination Areas, or Airborne Radioactivity Areas should monitor as specified in Article 338.

333 Radiological Material Areas

1. Minimum requirements for entry into Radioactive Material Areas should include the following:
 - a. Radiological Worker I training should be required for unescorted entry into Radioactive Material Areas. The minimum training required for individuals entering with a qualified escort should be GERT (see Article 635).
 - b. Personnel dosimetry.

334 Radiation, High Radiation and Very High Radiation Areas

1. Minimum requirements for entry into Radiation Areas should include the following:
 - a. Radiological Worker I training (unescorted), GERT (with qualified escort);
 - b. Worker's signature on the Radiological Work Permit (RWP), as applicable;
 - c. Personnel dosimetry.
2. Physical controls to prevent inadvertent or unauthorized access to High (>1.0 rem per hour) and Very High Radiation Areas should be maintained in accordance with Appendix 3B.
3. Minimum requirements for each entry into High Radiation Areas should include the following:
 - a. Radiological Worker II training (or Radiological Worker I with High/Very High Radiation Area access training in accordance with Article 632.4) and training in the use of a survey meter (or dose rate indicating device), as described in Article 126;
 - b. Worker's signature on the RWP;
 - c. *Minimum requirements for each entry into High Radiation Areas shall [835.502(a)] include the following:*
 1. *Personnel and supplemental dosimeters shall [835.402(a)(5)] be worn. [RPP # 86]*

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2. *The area shall [835.502(a)(1)] be monitored as necessary during access to determine the dose rates to which the individuals are exposed. [RPP # 117]*
3. *Each individual shall [835.502(a)(2)] be monitored by a supplemental dosimetry device or other means capable of providing an immediate estimate of the individual's integrated equivalent dose to the whole body during the entry. [RPP # 118]*
4. A survey meter or dose rate indicating device should be available at the work area.
4. *Minimum requirements for each entry into a High Radiation Area where dose rates exist such that a worker could exceed a whole body dose of 1 rem in one hour shall [835.402(a)(5)] include those items listed in Article 334.3 and a determination of the worker's current exposure, based on primary and supplemental dosimeter readings [RPP # 86] and should include the following:*
 - a. Pre-job briefing, as applicable;
 - b. Review and determination by the Radiological Control organization regarding the required level of Health Physics Technician coverage.
5. *Minimum requirements for entry into Very High Radiation Areas shall [835.502(c)] include the controls specified in Articles 334.3 and 334.4. In addition, a survey shall [835.502(c)] be made prior to the first entry into a Very High Radiation Area after the source has been secured or shielded to verify the very high radiation field has been terminated. [RPP # 125]*
6. Facility operations personnel should be notified prior to personnel entry to areas where operational or system changes made by operations personnel could result in significantly increased area dose rates.
7. *The number, issue and use of keys shall [835.502(b)(4)] be strictly controlled where locked entryways are used to control access to High and Very High Radiation Areas. [RPP # 122]*
8. The Radiological Control organization should maintain an inventory of High and Very High Radiation Areas.
9. Weekly inspections of the physical access controls to High (>1.0 rem per hour) and Very High Radiation Areas should be made to verify controls are adequate to prevent unauthorized entry. For stand-by or inactive facilities inspection of the perimeter physical controls is adequate providing, upon entry, the internal physical access controls are verified.
10. *Written procedures shall [835.501(c)] be implemented to ensure the effectiveness and operability of barricades, devices, alarms, and locks. [RPP # 113]* Determination of the effectiveness of these control devices should also consider individual training and response.

335 Contamination, High Contamination, and Airborne Radioactivity Area

1. Minimum requirements for entry into Contamination Areas should include the following:
 - a. Radiological Worker II training (unescorted), GERT (with qualified escort);

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- b. Worker's signature on the RWP, as applicable;
- c. Minimum requirements for unescorted entry into Contamination Areas also include the following:
 1. Protective clothing, as required by the governing RWP;
 2. Personnel dosimetry, as appropriate.
2. Minimum requirements for entry into High Contamination or Airborne Radioactivity Areas should include the following:
 - a. Radiological Worker II training;
 - b. Worker's signature on the RWP;
 - c. Pre-job briefing for High Contamination or Airborne Radioactivity Areas, as applicable;
 - d. Respiratory protection when specified by the RWP;
 - e. Minimum requirements for unescorted entry into High Contamination or Airborne Radioactivity Areas should also include the following:
 1. Protective clothing;
 2. Personnel dosimetry, as appropriate.
3. Personnel exiting Contamination, High Contamination or Airborne Radioactivity Areas should remove protective clothing as specified in Appendix 3C; and should, when entering an uncontaminated area, perform whole body frisking to detect personnel contamination in accordance with Article 338.
4. ***Exit points from Contamination, High Contamination, or Airborne Radioactivity Areas shall [835.1102(a)] include the following:***
 - a. ***Step off pad located outside the exit point, contiguous with the area boundary; [RPP # 229]***
 - b. ***Step off pads maintained free of radioactive contamination; [RPP # 229]***
 - c. Labeled containers inside the area boundary for the collection of protective clothing and equipment; and
 - d. ***Contamination monitoring equipment located as close to the step off pad as background radiation levels permit. [RPP # 229]***
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.

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6. Protective clothing and monitoring requirements specific to benchtop work, laboratory fume hoods, sample stations and gloveboxes are identified in Article 347.
7. *Tools or equipment being removed from areas posted for surface or airborne radioactivity control shall [835.1102(a)] be monitored for release in accordance with Article 421 or for retention in the contaminated tool crib in accordance with Article 442.5. [RPP # 229]*
8. Administrative procedures should be developed as necessary to implement area access controls. These procedures should address measures implemented to ensure the effectiveness and operability of entry control devices, such as barricades, alarms, and locks.

336 Member of the Public Entry Requirements

1. This Manual identifies the 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 training and the use of escorts trained for the specific area:
 - a. Radiological Buffer Areas;
 - b. Radiation Areas;
 - c. Contamination Areas;
 - d. Radioactive Material Areas; or
 - e. Soil Contamination Areas.
3. Members of the public should be prevented from entering Very High Radiation Areas in accordance with Article 334.5 and should be prohibited access to High Radiation, High Contamination and Airborne Radioactivity Areas.
4. Training requirements for members of the public are identified in Article 622.
5. Requirements for minors are given in Article 214.
6. Table 3-2 summarizes member of public entry requirements.

337 Controlling the Spread of Contamination

The following measures should be evaluated in the work planning process to prevent the spread of contamination across the boundary of Contamination Areas, High Contamination Areas 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.

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3. Control and direct airflow from areas of lesser to greater removable contamination.
4. *The following measures shall [835.1102(a)] be used to prevent the spread of contamination across the boundary of Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas: Use engineering controls and containment devices such as glovebags, gloveboxes, and tents. [RPP # 229]*

Table 3-2, Tank Farms Escorted Entry Requirements

Hanford Site						
<i>Escorted Entry Requirements</i>						
Areas	Hanford Dosimeter	Non-Hanford Worker	Hanford Worker	Qualified Escort	Exit Contam Survey	Prot. Clothing ^(e)
Radiologically Controlled Area		Orientation	Orientation	X		
Radiological Buffer Area	X ^(a)	Orientation	GERT	X	X ^(d)	
Radioactive Materials Area	X	Orientation	GERT	X		
Radiation Area	X	Orientation	GERT	X		
Contamination Area	X	Orientation	GERT	X	X	(e)
Soil Contamination Area	(c)	Orientation	GERT	X	X ^(b)	(b)
High Radiation Area ^(f)						
Very High Radiation Area ^(f)						
High Contamination Area ^(f)						
Airborne Radioactivity Area ^(f)						

(a) As applicable. Not all buffer areas require dosimetry.
 (b) If required by the applicable RWP.
 (c) The need for a dosimeter will be determined in accordance with individual TOC implementing procedures.
 (d) For Radiological Buffer Areas surrounding Contamination, High Contamination, and Airborne Radioactivity Areas.
 (e) Personnel Protective Clothing as required by the applicable RWP.
 (f) Visitor entry prohibited. Entry into such an area requires qualification as a Radiological Worker. See Articles 334, 335, and 336.

Note: Visitor Orientation meets all applicable 10 CFR 835 requirements for GERT and is valid for 30 days.

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Table 3-3, Summary of Requirements for Unescorted Access

Summary of Requirements for Unescorted Access ^(a)								
Area	Minimum Training			Personnel Dosimetry	RWP	Supplemental Dosimetry	Personnel Contamination Survey	Personnel Protective Clothing (PPE)
	GERT	Radiological Worker I	Radiological Worker II					
Radiologically Controlled Area	X							
Radiological Buffer Areas		X		X ^(h)			X ^(c)	
Posted Radioactive Material Areas		X		X				
Radiation Areas		X		X	X			
High Radiation Areas			X ^(d)	X	X	X		
Very High Radiation Areas			X ^(d)	X	X	X		
Contamination Areas			X	X ^(b)	X		X	X
High Contamination			X	X ^(b)	X		X	X
Airborne Radioactivity ^(e)			X	X	X		X	X
Soil Contamination	X		X ^(f)	X ^(g)	X ^(f)		X ^(g)	X ^(g)
Underground RMA			X ^(f)	X ^(g)	X ^(f)		X ^(g)	X ^(g)

Notes:

- Trained escorts may be required to comply with other safety and health requirements.
- The Project/Activity Radiological Control organization will determine the need for a dosimeter.
- For Radiological Buffer Areas surrounding Contamination, High Contamination, and Airborne Radioactivity Areas.
- Radiological Worker I and High/Very High Radiation Area training.
- Respirator required for access to airborne areas when specified on the RWP. Respirator fit and pulmonary function test required prior to receipt of respirators.
- Radiological Worker II and RWP required for work that disturbs the soil.
- As determined by the applicable RWP.
- As applicable. Not all Buffer Areas require dosimetry.

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338 Monitoring for Personnel Contamination

1. Personnel should perform a whole body frisk immediately upon entry into an uncontaminated area after exiting Contamination Areas, High Contamination Areas and Airborne Radioactivity Areas and should perform a whole body frisk as directed by the RWP or the Radiological Control organization. When exiting an Asbestos Regulated Area, the alternative frisking instructions in Article 338.4 should be followed.
2. In addition to the above, personnel exiting a Radiological Buffer Area established for contamination control 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 worker has already performed a whole body frisk.
3. Where frisking cannot be performed at the exit from Contamination Areas, High Contamination Areas or Airborne Radioactivity Areas due to high background radiation levels, personnel 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. When exiting an Asbestos Regulated Area, a release survey should be performed on the exterior surfaces of respiratory protection equipment prior to the worker entering the shower. After showering, workers should doff their respiratory protection and undergo facial monitoring for radioactive contamination using appropriate instrumentation. This practice allows for concurrent compliance with the health and safety requirements for egress from an Asbestos Regulated Area.
5. Personnel frisking should be performed using instruments that meet the minimum detection requirements of Article 221.2. Guidelines for personnel frisking are provided in Appendix 3D.
6. The use of automated personnel contamination monitors is encouraged.
7. Items that remain on the individual after completing the anti-contamination doffing process should be monitored with the person during the whole body frisk.
8. Instructions for personnel frisking should be posted adjacent to personnel frisking instruments or monitors.
9. The personnel frisking requirements contained 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. At such facilities, additional emphasis should be placed on worker bioassay programs and routine contamination and air sampling programs.

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PART 4 Radiological Work Controls

341 Requirements

- 1. Radiological work activities shall [835.501(d)] be conducted as specified by the controlling technical work document and Radiological Work Permit. [RPP # 114]***
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

- 1. Contamination levels caused by ongoing work shall [835.1102(a)] be monitored and maintained ALARA. [RPP # 229]*** Work should be curtailed and decontamination performed at pre-established levels, taking into account worker exposure.
2. Tools and equipment should be inspected to verify operability before being brought into Contamination, High Contamination or Airborne Radioactivity Areas.
3. The use of radiologically clean tools or equipment in Contamination, High Contamination or Airborne Radioactivity Areas should be minimized by the implementation of a contaminated tool crib in accordance with Article 442.5. When such use is necessary, tools or equipment with complex or inaccessible areas should be wrapped or sleeved to minimize contamination.
4. Engineering controls, such as containment devices, portable or auxiliary ventilation and temporary shielding, should be installed in accordance with the technical work documents and inspected prior to use.
5. Hoses and cables entering the work area should be secured to prevent the spread of contamination or safety hazards.
6. The identity of components and systems should be verified prior to work.
7. Work activities and shift changes should be scheduled to prevent idle time in radiation areas.
8. Where practicable, parts and components should be removed to areas with low dose rates to perform work.
9. 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.
10. Reserved.
11. To minimize intakes of radioactive material by personnel, smoking, eating, or chewing should not be permitted in Contamination, High Contamination or Airborne Radioactivity Areas. When a potential exists for personnel heat stress, drinking may be permitted within a Contamination Area under the following conditions and controls:

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- 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. At a minimum, worker's hands and faces are monitored for contamination prior to drinking;
- d. Participating workers are monitored as part of the bioassay program; and
- e. The applicable requirements and controls are described in approved procedures.

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, work supervisors should periodically review ongoing jobs to ensure prescribed radiological controls are being implemented.
2. Radiological Control personnel should conduct frequent 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.

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345 Stop Radiological Work Authority

1. Health Physics Technicians and their supervisors, line supervision, and any worker have the authority and responsibility to stop radiological work activities for any of the following reasons:
 - a. Inadequate radiological controls;
 - b. Radiological controls not being implemented; or
 - c. Radiological control hold point not being satisfied.
2. Stop radiological work authority should be exercised in a justifiable and responsible manner.
3. Once radiological work has been stopped, it should not be resumed until proper radiological control has been reestablished (see Part 4 of this Chapter).
4. Resumption of radiological work requires the approval of the line manager responsible for the work and the Radiological Control Manager. ***Operations which have been suspended as a result of a dose in excess of the General Employee occupational dose limits specified in Table 2-1, except those received in accordance with the planned special exposure provisions in Article 213.3, shall [835.1301(d)] be resumed only with the approval of DOE. [RPP # 250]***

346 Response to Abnormal Situations

1. This Manual or TOC procedures should establish requirements for alarm response procedures. 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;
 - b. Immediately exit the area; and
 - 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;
 - b. Alert others;
 - c. Affected personnel immediately exit the area; and
 - d. Notify Radiological Control personnel.

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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; and
 - 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 that may be available to minimize cross-contamination, such as putting a glove on a contaminated hand; and
 - d. Take follow-up actions in accordance with Article 541, when applicable.
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; and
 - f. Notify Radiological Control personnel.

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

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

1. A Radiological Work Permit (RWP) should be issued to control radiological work in localized benchtop areas, laboratory fume hoods, sample sinks, and gloveboxes.
2. The following controls apply to localized benchtop and laboratory fume hood operations:
 - a. Protective clothing should, at a minimum, include lab coats and gloves. Gloves should be secured at the wrist as necessary.
 - b. Shoe covers should be considered based on the potential for floor contamination.

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- c. Workers should periodically monitor their hands during work.
- d. 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 instituted.
- e. 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. Workers should perform a whole body frisk.
- f. Glove boxes should be inspected for integrity and operability prior to use.
- g. Glove boxes should be marked with or survey measurements should be posted to identify whole body and extremity dose rates.

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. Measures for controlling hot particles, as identified in items 2 through 6 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; or
 - c. Upon direction of the Radiological Control organization.
2. Areas or operations with the potential for hot particle contamination should be surveyed in accordance with Article 554.8.
3. Contamination Area posting should be annotated to specifically identify the presence of hot particles.
4. Access to hot particle areas should be controlled by 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 skin exposure;
 - b. Additional personal protective equipment and clothing;
 - c. Direct Radiological Control coverage during work or assistance during protective clothing removal; and
 - d. Use of sticky pads or multiple step-off pads.

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5. 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.
6. Response to hot particle skin contamination of personnel 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; and
 - d. Evaluation of work control adequacy.

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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 personnel 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 not to assign blame, but to establish and record the facts.

1. Critiques should be conducted for successes and abnormal events.
2. Critique leaders should be trained in the required elements of the critique process and the appropriate methods of conducting and controlling the critique.
3. 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.
4. Approved company-level event investigation processes should be followed.
5. Evaluation of complex evolutions or events may require multiple critiques.

352 Post-Job Reviews

Performance should be reviewed after completion of non-routine radiological work. Criteria established to trigger the conduct of a formal post-job review include:

- a. An actual collective equivalent dose of 5 person-rem or greater.
- b. Actual doses for a task outside the range of $\pm 25\%$ of pre-job estimates of 1000 person-mrem Total Effective Dose (TED).
- c. Use of the stop radiological work authority.
- d. A task results in a reportable radiological occurrence per DOE 232.1, Group 4, "Personnel Radiation Protection" reporting criteria.
- e. For identification of significant lessons learned.

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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 training program and related operations.

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PART 6 Special Applications

This Part provides supplemental information to augment the basic requirements of the Manual. Articles 361 through 365 provide information to be used in developing the Site-Specific Radiological Control Manual. 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

Reserved

362 Uranium Operations

Reserved

363 Tritium Operations

Reserved

364 Accelerator Operations

Reserved

365 Radiation Generating Devices

Formal operating procedures should be used to control the operation and maintenance of radiation-generation devices (RGD). ***The Contractor shall maintain a current listing of RGDs. This listing shall identify the responsible individual for each listed RGD [HSD K.1].*** Formal procedures used in this manner should meet the requirements of Articles 321, 322, and 323. 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.

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

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- b. Flash x-ray
 - c. Sealed source irradiators used for diffraction studies.
3. ***The contractor shall establish the radiological control and operational requirements for incidental x-ray devices such as electron microscopes, electron beam welders and field x-ray diffraction devices [HSD K.3].***
4. Devices for medical use should be registered with the appropriate regulatory agency.
5. Control requirements for radiographic devices are:
- a. On-site operations with devices containing sealed sources should be conducted in accordance with the requirements contained in Title 10 CFR Part 34 entitled, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations."
 - 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. ***The contractor shall ensure that on-site operations of RGDs, conducted by off-site contractors are approved by the cognizant site Radiological Control organization in coordination with the organization utilizing the off-site contractor. The contractor shall ensure that the off-site contractor possesses an approved DOE Radiation Protection program, Nuclear Regulatory Commission license or Agreement State license and that operational and emergency procedures are current and available [HSD K.2].***
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.

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PART 7 Reserved

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Appendix 3A, Checklist for Reducing Occupational Radiation Exposure

Preliminary Planning and Scheduling

- 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
- 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 radiation areas
- State requirements for standard tools
- Consider special tools, including robots
- State staging requirements for materials, parts and tools
- Incorporate radiological control hold points
- Minimize discomfort of workers
- Revise estimates of person-rem
- Prepare Radiological Work Permits (RWPs)

Temporary Shielding

- Design shielding to include stress considerations
- Control installation and removal by written procedure
- Inspect after installation
- Conduct periodic radiation surveys
- Prevent damage caused by heavy lead 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

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Appendix 3A, Checklist for Reducing Occupational Radiation Exposure (cont.)

- Shield position 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

- Rehearse
- Use mock-ups duplicating working conditions
- Use photographs and videotapes
- Supervisors conduct briefings of workers

Performing Work

- Comply with technical work documents and RWPs
- Post radiation levels
- Keep excess personnel out of radiation areas
- Minimize radiation exposure
- Supervisors and workers keep track of radiation exposure
- Workers assist in radiation and radioactivity measurements
- Delegate radiological control monitoring responsibilities
- Evaluate use of fewer workers
- Reevaluate reducing radiation exposures
- Compare actual collective dose against pre-job estimate
- Review work practices to see if changes will reduce dose
- Coordinate personnel at the job site to reduce nonproductive time

Appendix 3B, Physical Access Controls for High and Very High Radiation Areas

1. *One or more of the following controls shall [835.502(b)] be used for each entrance or access point to a High Radiation Area where radiation levels exist such that an individual could exceed an equivalent dose to the whole body of 1.0 rem (0.01 sievert) in any one hour at 30 centimeters from the source or from any surface the radiation penetrates:*
 - a. *A control device that prevents entry to the area when high radiation levels exist or that, upon entry, causes the radiation level to be reduced below the level that defines a High Radiation Area; [RPP # 119]*
 - b. *A device that functions automatically to prevent use or operation of the radiation source or field while individuals are in the area; [RPP # 120]*
 - 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; [RPP # 121]*
 - d. *Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained; [RPP # 122]*
 - e. *Continuous direct or electronic surveillance that is capable of preventing unauthorized entry; [RPP # 123]*
 - f. *A control device that will automatically generate 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. [RPP # 124]*
2. *In addition to the above requirements, additional measures shall [835.502(c)] be implemented to ensure individuals are not able to gain unauthorized or inadvertent access to Very High Radiation Areas when dose rates are in excess of the posting requirements of Table 2-3. [RPP # 125]*
3. *No control(s) shall [835.502(d)] be established in a High or Very High Radiation Area that would prevent rapid evacuation of personnel. [RPP # 126]*

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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, and regard for non-radiological hazards that may be present. A full set and double set of protective clothing typically includes:

Full Set of PCs

- a. Coveralls
- b. Gloves
- c. Shoe covers
- d. Rubber overshoes
- e. Hood, as applicable

Double Set of PCs

- a. Two pairs of coveralls
 - b. Two pairs of gloves
 - c. Two pairs of shoe covers
 - d. Rubber overshoes
 - e. 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. Shoe covers 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 hard hats in Contamination Areas should be controlled by the Job Hazard Analysis (JHA) process.
 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.
 8. When restricted by Industrial Hygiene due to heat stress concerns, 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.

Appendix 3C, Contamination Control Practices (cont.)

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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. Instructions for protective clothing removal comparable to the sequence presented below should be posted adjacent to the step-off pad in accordance with Article 325.6.

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, remove items from outer pocket, and then do the following in sequence:

1. Remove rubber overshoes
2. Remove outer gloves
3. Open hood from bottom to top and remove from front to rear
4. Remove respiratory protection, as applicable
5. Remove all exposed tape
6. Remove supplemental dosimetry and make sure coverall pockets are empty, as applicable
7. Take down barrier closure, as applicable
8. Pull down coveralls, turning them inside-out
9. Remove tape then shoe covers, placing shoes onto the step off pad
10. Replace barrier closure, as applicable
11. Remove surgeon's gloves and liners, as applicable
12. Obtain or perform a whole body survey
13. Obtain release survey of supplemental dosimetry and other materials.

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. Remove 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.

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Appendix 3C, Contamination Control Practices (cont.)

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. Replace barrier closure, as applicable
15. Commence whole body frisking
16. 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.

Use of Multiple Step-Off Pads

1. Multiple step-off pads should be used to control exit from High Surface 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.

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Appendix 3D, Guidelines for Personnel Contamination Monitoring with Hand Held Survey Instruments

General Requirements

1. Perform a source response check of the instrument to verify the instrument is in service.
2. Set the instrument to the proper scale and make sure the audio output can be heard during frisking.
3. Hold probe approximately 1/4 inch from surface being surveyed.
4. Move probe slowly over surface, approximately 2 inches per second.
5. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for instrument response.
6. If the count rate increases to a value greater than a pre-established contamination limit or the instrument alarms, remain in the area and notify Radiological Control personnel.
7. The whole body frisk should take at least two to three minutes.

Performance of Monitoring:

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)
 - d. Chest and abdomen
 - e. Back, hips and seat of pants
 - f. Legs (pause at each knee)
 - g. Shoe tops
 - h. Shoe bottoms (pause at sole and heel)
 - 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 person to monitor their hands before handling the probe.

*Comparable **instructions** to those presented here should be posted adjacent to monitoring instruments in accordance with Article 338.8.

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RADIOACTIVE MATERIALS
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PART 1 Radioactive Material Identification, Storage and Control

For the purposes of this Manual, radioactive material is any material, equipment or system component determined to be contaminated or suspected of being contaminated. Items located in known or suspected Contamination, High Contamination or Airborne Radioactivity Areas and having the potential to become contaminated are considered radioactive material. Radioactive material also includes activated material, sealed and unsealed sources, and materials that emit radiation. Controls for sealed sources are described in Article 431.

411 Requirements

1. Materials in Contamination, High Contamination or Airborne Radioactivity Areas should be considered contaminated until surveyed and released. 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. These survey and release requirements do not apply to Airborne Radio-activity Areas where only gaseous, short-lived (half-life of 1 hour or less) activation products are present.
2. ***Except for sealed and unsealed sources, radioactive material located within Radioactive Material, Radiation, High Radiation, Very High Radiation, Contamination, High Contamination or Airborne Radioactivity Areas does not require specific labeling, provided sufficient information is provided to permit individuals to take precautions to avoid or control exposures [835.606(a)(1)]. [RPP # 150]***
 - a. Due to the types of activities performed by the TOC, one or more of the of the following methods should be used to control the potential for inadvertent removal of radioactive material from Radioactive Material, Radiation, High Radiation, and Very High Radiation Areas:
 1. Manage item(s) as Special Nuclear Material, or;
 2. Item(s) bear a durable clearly visible standard radiation warning trefoil and the words “Caution Radioactive Material” or “Danger Radioactive Material”, or;
 3. The outer containers in the area are labeled in accordance with Articles 412.3, 412.4 and 412.5, or;
 4. The access or access controls to the Radioactive Material Area inform the individuals entering the area of the container radiological status and that additional radiological controls are required for removal of any item from the area.
3. Reserved.

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412 Radioactive Material Labeling

1. *Except as provided in Article 411.2 and 412.2, each item or container of radioactive material shall [835.605] bear a durable, clearly visible label bearing the standard radiation warning trefoil and the words “Caution, Radioactive Material” or “Danger, Radioactive Material.”[RPP # 148] The label shall [835.605] also provide sufficient information to permit individuals handling, using, or working in the vicinity of the items or containers to take precautions to avoid or control exposures. [RPP # 149]*
2. *Items and containers may be excepted from the radioactive material labeling requirements of Article 412.1 when [835.606(a)]:*
 - a. *The quantity of radioactive material is less than one-tenth of the values specified in Appendix 4A and is less than 0.1 Ci; or [RPP # 151]*
 - b. *Packaged, labeled, and marked in accordance with the regulations of the Department of Transportation or DOE Orders governing radioactive material transportation; or [RPP # 152]*
 - c. *Inaccessible, or accessible only to individuals authorized to handle or use them, or to work in the vicinity; or [RPP # 153]*
 - d. *Installed in manufacturing, process, or other equipment, such as reactor components, piping, and tanks, or [RPP # 154]*
 - e. *The radioactive material consists solely of nuclear weapons or their components. [RPP # 155]*
3. *Labels shall [835.601(a)] include the standard radiation warning trefoil in black or magenta imposed upon a yellow background. [RPP # 127] Lettering should be magenta or black. Magenta is the preferred color. Radioactive material labels applied to sealed radioactive sources may be excepted from these color specifications [835.606(b)]. [RPP # 156]*
4. Labels should include contact radiation levels, removable surface contamination levels (specified as alpha or beta-gamma), dates surveyed, surveyor’s name and description of items.
5. Packaged radioactive material should have the label visible through the package or affixed to the outside.
6. *The labeling requirements of 10 CFR 835 may be modified to reflect the special considerations of DOE activities conducted at private residences or businesses. Such modifications shall [835.601(c)] provide the same level of protection to individuals as the existing provisions in 10 CFR 835. [RPP # 129 & 130]*

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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 controlled in accordance for Article 421. These items should be securely wrapped or placed in a 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. Impermeable wrapping material should be used for packaging radioactive material. The use of yellow wrapping material is encouraged; however, under some circumstances it may be more appropriate, for ALARA reasons, to use other colors of wrapping material. This practice is acceptable as long as the wrapped package is supplemented with additional markings that retain an equivalent ability to visually identify that the package contains radioactive material. This marking material should consist of a yellow background with magenta markings, including the standard radiation trefoil symbol. These markings should be clearly visible and securely attached on all exposed sides. These requirements are supplemental to any applicable labeling requirements. Yellow wrapping material should not be used for non-radiological purposes.
5. The amount of combustible material used in packaging should be minimized.

414 Radioactive Material Storage

1. Radioactive material should be stored in a designated Radioactive Material Area unless exempted in Article 236.4. 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.
2. Decontamination or disposal of radioactive material is the preferred alternative to establishing Radioactive Material Areas.
3. Each Radioactive Material Area should be approved by the Project/Activity Radiological Control Manager or designee.
4. A custodian should be assigned responsibility for each Radioactive Material Area. A custodian may have responsibility for more than one storage area.
5. The custodian (or designee) should conduct monthly walkthroughs of Radioactive Material Areas to check container integrity.

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6. The custodian should conduct annual or more frequent reviews of each Radioactive Material Area, with emphasis on decontamination, movement of material to long-term storage locations and disposal of unneeded material.
7. Storage of non-radioactive material in a Radioactive Material Area is discouraged.
8. Radioactive material should be stored in a manner that reduces combustible loading. The use of cardboard containers for storage is discouraged.
9. Storing flammable or combustible materials in or adjacent to Radioactive Material Areas is discouraged without sufficient justification.
10. Fire protection measures, such as smoke detectors, water sprinklers and fire extinguishers, should be considered when establishing a Radioactive Material Area.

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PART 2 Release and Transportation of Radioactive Material

421 Release to Controlled Areas

1. Radioactive material in Contamination, High Contamination or Airborne Radioactivity Areas should be surveyed prior to release. *Except as provided in 421.2, material and equipment in Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas shall [835.1101(a)] not be released to a controlled area if:*

- a. *Removable surface contamination levels on accessible surfaces exceed the removable surface contamination values specified in Table 2-2; or [RPP # 224]*
- b. *Prior use suggests that the removable surface contamination levels on inaccessible surfaces are likely to exceed the removable surface contamination values specified in Table 2-2. [RPP # 225]*

Radioactive material to be released to uncontrolled areas should be surveyed in accordance with Article 422.

2. *Material and equipment with fixed contamination levels that exceed the total surface contamination values specified in Table 2-2 may be released for use in controlled areas outside of radiological areas only under the following conditions:*
 - a. *Removable surface contamination levels are below the removable surface contamination values specified in Table 2-2 [835.1101(c)(1)]; and [RPP # 227]*
 - b. *The material or equipment is routinely monitored and clearly marked or labeled to alert personnel of the contaminated status [835.1101(c)(2)]. [RPP #228] 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.*
3. *Material and equipment exceeding the removable surface contamination values specified in Table 2-2 may be conditionally released for movement on-site from one radiological area or radioactive material area for immediate placement in another radiological area or radioactive material area only if appropriate monitoring is performed and appropriate controls for the movement are established and exercised [835.1101(b)]. [RPP #226] Controls shall [835.402] 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. [RPP # 89]*
4. Materials not immediately removed from Contamination, High Contamination, or Airborne Radioactivity Areas after survey should be controlled to prevent contamination while awaiting release.
5. *The results of monitoring for the release and control of material and equipment shall [835.703(c)] be documented and maintained. [RPP # 182] These records should describe the property, date of*

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last monitoring, identity of the person who performed the monitoring, type and identification number of the monitoring instruments used, and monitoring results.

6. Reserved.

422 Release to Uncontrolled Areas

1. DOE O 458.1 establishes the radiological criteria for releasing material to uncontrolled areas. Release of radioactive material to uncontrolled areas should be performed in accordance with the requirements of DOE O 458.1. ***A radiological clearance (release) program shall be established to assure that real property, personal property, materials and equipment released from the Hanford Site fully comply with regulations and DOE requirements prior to radiological release of this property to the public [HSD E.9].***
2. ***Methods used to survey personal property, equipment and material for uncontrolled release must support a minimum statistical confidence of 67% for items determined unlikely to be contaminated and 95% for items determined likely to be contaminated [HSD E.10].***
3. Material being released should be evaluated for internal contamination and contamination under any coating in accordance with DOE O 458.1.
4. The criteria for unrestricted release of materials established in DOE O 458.1 may be more stringent than those established in this Manual for release to Controlled Areas. ***Previously approved guidelines and limits (including the surface activity guidelines in Table 4-1) may continue to be applied and used as Pre-Approved Authorized Limits until they are replaced or revised under DOE O 458.1 [HSD E.11].***
5. Material not released after survey should be controlled to prevent contamination while awaiting release.
6. Radiological labeling should be removed from or defaced on material prior to release for unrestricted use.

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**Table 4-1: Surface Activity Guidelines (DOE Order 5400.5 as Supplemented by DOE [1995])
Allowable Total Residual Surface Contamination (dpm/100 cm²) [HSD Table 1]**

<i>Radionuclides^b</i>	<i>Average^{c, d}</i>	<i>Maximum^{e, f}</i>	<i>Removable^f</i>
<i>Group 1 - Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129</i>	<i>100</i>	<i>300</i>	<i>20</i>
<i>Group 2 - Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133</i>	<i>1,000</i>	<i>3,000</i>	<i>200</i>
<i>Group 3 - U-nat, U-235, U-238, associated decay products, and alpha emitters</i>	<i>5,000</i>	<i>15,000</i>	<i>1,000</i>
<i>Group 4 - Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90, tritium, and others noted above^g</i>	<i>5,000</i>	<i>15,000</i>	<i>1,000</i>
<i>Tritium (applicable to surface and subsurface)^h</i>	<i>N/A</i>	<i>N/A</i>	<i>10,000</i>

- ^{a.} As used in this table, disintegration per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- ^{b.} Where surface contamination by both alpha and beta-gamma emitting radionuclides exists, the limits established for alpha and beta-gamma emitting radionuclides should apply independently.
- ^{c.} Measurements of average contamination should not be averaged over an area of more than 1 m². For objects of smaller surface area, the average should be derived for each such object.
- ^{d.} The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.
- ^{e.} The maximum contamination level applies to an area of not more than 100 cm².
- ^{f.} The amount of removable material per 100 cm² of surface area should be determined by wiping an area of that size with a dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping 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.
- ^{g.} 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.
- ^{h.} Property recently exposed or decontaminated, should have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 are not applied to tritium. The Department has reviewed the analysis conducted by the DOE Tritium Surface Contamination Limits Committee (Recommended Tritium Surface Contamination Release Guides [DOE 1991]), and has assessed potential doses associated with the release of property containing residual tritium. The Department recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non-removable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.

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423 Transportation and Receipt of Radioactive Material

1. 49 CFR 170 through 180 describe requirements for inspecting and surveying packages, containers, and transport conveyances prior to off-site transport. These regulations apply to shipments transported by non-DOE conveyances including on-site transfers of shipments by non-DOE conveyances received from or destined to off-site locations.
2. DOE O 460.1C and DOE O 460.2A provide requirements that are in conformance with 49 CFR, for transportation of radioactive material using any conveyance. 10 CFR 835.1(b)(5) excludes radioactive material transportation activities that are performed in compliance with applicable DOE Orders from the requirements of 10 CFR 835. However, radioactive material transportation does not include preparation of materials for shipment, packaging and labeling, or performance of surveys required for occupational radiation protection. Therefore, these activities should be conducted in accordance with 10 CFR 835 and should be conducted in accordance with the provisions of this Manual.
3. Table 2-2 removable contamination values are more limiting than 49 CFR requirements. Except as specified below, Table 2-2, removable contamination values should, be used as controlling limits for on-site and off-site transportation when using a DOE conveyance. For any shipment using a container that requires an on-site SARP or other safety analysis document, 49 CFR 173 contamination values may be used. When a shipment is received from an off-site destination, by a non-DOE conveyance, the 49 CFR 173 contamination values should be applicable for all subsequent on-site transfers to the ultimate on-site destination.
4. ***On-site transfers over nonpublic thoroughfares or between facilities on the same site shall [835.104] be performed in accordance with written procedures utilizing pre-approved routes. [RPP # 39]*** The procedures should include requirements to ensure appropriate monitoring and control of the radioactive material and should be approved by the Radiological Control organization.
5. On-site transfers over public thoroughfares should be performed in accordance with Department of Transportation, state and local shipping requirements and pre-approved agreements.
6. Off-site shipments of radioactive material, including subcontractors' handling of off-site shipments, should be controlled and conducted in accordance with this Manual and applicable Federal, state and local regulations.
7. Before shipment, and upon receipt of a radioactive 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.
8. Before shipment, and upon receipt of a radioactive shipment, a comparison of package count to the shipping manifest should be made to ensure accountability.
9. Transport conveyances should be visually inspected prior to loading to ensure the trailers are acceptable for the intended use.

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10. Transport conveyances should be radiologically surveyed before loading, especially when using commercial carriers specializing in radioactive transport.
11. 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.
12. The site emergency plan should describe appropriate responses for potential on-site radioactive material transportation accidents.
13. Drivers of DOE and non-DOE motor vehicles should have a copy of their emergency response plan, or the emergency response information required by 49 CFR 172.600, during transport on-site or during off-site transportation.
14. *If packages containing quantities of radioactive material in excess of a Type A quantity (as defined at 10 CFR 71.4) are expected to be received from radioactive material transportation, arrangements shall [835.405(a)] be made to either:*
 - a. *Take possession of the package when the carrier offers it for delivery; or [RPP # 98]*
 - b. *Receive notification as soon as practicable after arrival of the package at the carrier’s terminal and to take possession of the package expeditiously after receiving such notification. [RPP # 99]*
15. *Upon receipt from radioactive material transportation, external surfaces of packages known to contain radioactive material shall [835.405(b)] be monitored if the package:*
 - a. *Is labeled with a Radioactive White I, Yellow II, or Yellow III label (as specified at 49 CFR 172.403 and 172.436-440); or [RPP # 100]*
 - b. *Has been transported as low specific activity material (as defined at 10 CFR 71.4) on an exclusive use vehicle (as defined at 10 CFR 71.4); or [RPP # 101]*
 - c. *Has evidence of degradation, such as packages that are crushed, wet, or damaged. [RPP # 102]*
16. *The monitoring required by Article 423.15 shall [835.405(c)] include:*
 - a. *Measurements of removable contamination levels, unless the package contains only special form (as defined at 10 CFR 71.4) or gaseous radioactive material; and [RPP # 103]*
 - b. *Measurements of the radiation levels, if the package contains a Type B quantity (as defined at 10 CFR 71.4) of radioactive material. [RPP # 104]*
17. *The monitoring required by Article 423.15 shall [835.405(d)] be completed as soon as practicable following receipt of the package, but no later than 8 hours after the beginning of the working day following the receipt of the package. [RPP # 105]*

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- 18. The monitoring required by Article 423.15 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 [835.405(e)]. [RPP # 106]***
- 19. The requirements in Articles 234, 235 and 330 of this manual do not apply to radioactive material transportation by DOE or a DOE contractor conducted [835.1(d)(1)]:***
- a. Under the continuous observation and control of an individual who is knowledgeable of and implements required exposure control measures, or [RPP # 11]***
 - b. In accordance with Department of Transportation regulations or DOE orders that govern such movements. [RPP # 12]***

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PART 3 Radioactive Source Control

431 Radioactive Source Controls

The data presented in Appendix 4A is to be used for identifying accountable sealed radioactive sources as defined in the Glossary, establishing the need for radioactive material area posting in accordance with Article 236, and establishing the need for radioactive material labeling in accordance with Article 412.

Sealed radioactive sources shall [835.1201] be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources. [RPP # 235]

1. Written procedures should 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. The Radiological Control Manager should approve these procedures.
2. Accountable sealed sources, or their storage containers should be labeled with the radiation symbol and “CAUTION RADIOACTIVE MATERIAL” or “DANGER RADIOACTIVE MATERIAL.” The label should also provide sufficient information to permit individuals handling, using, or working in the vicinity of the items or containers, to take precautions to avoid or control exposures. The label should include information such as the radionuclide, the quantity of radioactive material and the date of quantity estimate. However, such labels are exempt from the normal color scheme of magenta or black on yellow. 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 [835.1202(a)] be inventoried at intervals not to exceed six months. This inventory shall [835.1202(a)]:***
 - a. ***Establish the physical location of each accountable sealed radioactive source, [RPP # 236]***
 - b. ***Verify the presence and adequacy of associated postings and labels, and [RPP # 237]***
 - c. ***Establish the adequacy of storage locations, containers and devices. [RPP # 238]***
4. Sealed radioactive sources that are below the accountability activity of Appendix 4A, should be inventoried as required by procedure.
5. ***Except for sealed radioactive sources consisting solely of gaseous radioactive material or tritium, each accountable sealed radioactive source shall [835.1202(b)] be subject to a source leak test upon receipt, when damage is suspected, and at intervals not to exceed six months. [RPP # 239] Source leak tests shall [835.1202(b)] be capable of detecting radioactive material leakage equal to or exceeding 0.005 μ Ci. [RPP # 240]***
6. ***Notwithstanding the requirements of Article 431.5, an accountable sealed radioactive source is not subject to periodic source leak testing if that source has been removed from service [835.1202(c)]. [RPP # 241] Such sources shall [835.1202(c)] be stored in a controlled location and subject to***

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periodic inventory in accordance with Article 431.3 and subject to leak testing prior to being returned to service. [RPP # 242]

7. ***Notwithstanding the requirements of Articles 431.3 and 431.5, an accountable sealed radioactive source is not subject to periodic inventory and source leak testing if that source is located in an area that is unsafe for human entry or otherwise inaccessible [835.1202(d)]. [RPP # 243]*** When the conditions that restrict access to the area have been terminated, the sealed radioactive source should be inventoried and either leak tested or removed from service as described in Article 431.6 before allowing uncontrolled access to the area.
8. ***An accountable sealed radioactive source found to be leaking radioactive material shall [835.1202(e)] be controlled in a manner that minimizes the spread of radioactive contamination. [RPP # 244]*** These controls should include wrapping or containing the source, applying appropriate labels, and removing the source from service. A minimum detection threshold of equal to or less than 0.005 μCi will be used.
9. Procurement of radioactive sources should be coordinated with the Radiological Control organization.
10. Receipt surveys of radioactive material shipments should be performed by the Radiological Control organization in accordance with Articles 423, 552 and 554.
11. 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.
12. DOE O 231.1B establishes the inventory reporting requirements for accountable sealed radioactive sources and radioisotope thermoelectric generators (RTGs) and transaction reporting requirements for Category 1 and 2 radioactive sealed sources, as defined in DOE 231.1B Attachment 1, to DOE centralized database repository, the Radiological Source Registry and Tracking (RSRT) database.
 - a. Accountable source inventories and transaction reporting for Category 1 and Category 2 radioactive sealed sources should be reported to the RSRT in accordance with DOE 231.1B

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PART 4 Solid Radioactive Waste Management

441 Requirements

1. DOE O 435.1 describes how solid radioactive waste is treated, packaged, stored, transported and disposed.
2. Radiological operations generating radioactive waste should be designed and developed to promote minimization and permit segregation, monitoring, treatment, storage and disposal.
3. Radioactive waste minimization goals and practices should be developed and implemented.

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. The following practices should be utilized to support waste minimization:

1. Reserved.
2. Minimize quantities of hazardous materials, such as paints, solvents, chemicals, cleaners and fuels, entering Radiological Buffer Areas and take measures to prevent inadvertent radioactive contamination of these materials.
3. Substitute recyclable or burnable items in place of disposable ones and reuse equipment 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 Radiological Buffer 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.

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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.

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PART 5 Control of Radioactive Liquids and Airborne Radioactivity

451 Minimization and Control of Radioactive Liquid Waste

1. DOE O 451.1B provides criteria for minimizing the generation of radioactive liquid waste. Minimization should include evaluating operational requirements to reduce liquid usage and maximize recycling activities.
2. A water management program should be maintained to identify, trend and eliminate unnecessary sources of radioactive liquid waste and liquid mixed waste. This program should include aggressive measures to identify and repair leaks.
3. Activities that produce radioactive liquid waste should be suspended unless sufficient processing, collection and storage capacity is available to accommodate the waste.
4. DOE O 458.1 provides radioactive liquid waste discharge requirements.
5. Radioactive liquid waste discharges should be controlled on a batch basis to enhance monitoring capability and to reduce the potential for inadvertent release.
6. Radioactive liquid waste discharges should be analyzed prior to release, monitored during release, and the release terminated before exceeding predetermined limits.
7. Radioactive liquid waste that cannot be discharged should be solidified and disposed of as solid radioactive 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. At Hanford, radioactive drains that discharge to the environment are controlled by the Hanford Federal Facility Agreement and Consent Order commonly referred to as the Tri-Party Agreement (TPA). The elimination of radioactive liquid discharges is addressed in the TPA.
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

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- 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; and
 - d. Management controls to restrict the introduction of hazardous wastes into radioactive drain systems.

453 Control of Airborne Radioactivity

1. Processes and activities with the potential for producing airborne radioactivity should include engineering controls to limit releases whenever appropriate.
2. 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.
3. Preventive maintenance and surveillance procedures should be established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

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PART 6 Support Activities

461 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 solely designated for radiological control use should not be used for non-radiological work.
3. Previously used personal protective equipment and clothing should not be stored with personal street clothing unless released from radiological controls.
4. ***Cleaned Personal Protective Equipment, such as face shields and respirators, that come in to contact with the wearer's face, and company issued non-personal protective clothing, shall [835.1101(a)] be surveyed. [RPP # 224 & 225]*** Contamination levels should meet the requirements of Article 422. The use of statistically representative sampling is acceptable.
5. Laundered protective clothing should be surveyed using statistically representative sampling and should meet the following criteria prior to reuse:
 - a. Beta-gamma radioactivity less than 10,000 dpm/100 cm²
 - b. Alpha radioactivity less than 1,000 dpm/100 cm² for transuranics and other alpha emitters in the same Table 2-2 category, and less than 10,000 dpm/100cm² for uranium.
6. Reserved.

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 minimize both potential worker exposure and the volume of waste generated.
3. Clothing and equipment should be screened before they are laundered 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. Reserved.
6. Personal protective equipment and clothing should be inspected prior to each use. Clothing should be free of tears, separated seams, deterioration and damage, or repaired in a manner that provides the original level of protection.

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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.
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. Efforts should be made to reduce the level of contamination and the number and size of contaminated areas that cannot be eliminated.
6. Facility line management should be responsible for directing decontamination efforts.

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, loose surface 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 re-suspension, then HEPA filters are not necessary.
2. HEPA filters used in vacuum cleaner and portable air-handling equipment should meet the efficiency and construction requirements for HEPA filters in MIL-F-51068. 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 been opened, 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. DOE HDBK-1169-2003 Section 8.6.1, provides additional information on in-place testing of HEPA filters. For those vacuums that are specifically designed to be serviced and to allow debris removal without compromising the HEPA filter seal (e.g., the Nilfisk^{TM1} GS-80 and the Euroclean^{TM2} "HEPA filtered Portable Dust Collection System") do not have to be leak tested every time they are opened. If, however, the HEPA filter seal is affected during debris removal or servicing, then a leak test should be performed. Additional requirements for leak testing are contained in the applicable radioactive air emissions notice of construction.

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^{TM2} NILFISK-ADVANCE, INC. CORPORATION MINNESOTA 14600 21ST AVENUE N. MINNEAPOLIS MINNESOTA 55447

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3. Vacuum cleaners used for radiological work should be:
 - a. Uniquely marked and labeled
 - b. Controlled by an RWP
 - c. Controlled to prevent unauthorized use
 - d. Designed to ensure HEPA filter integrity under conditions of use
 - e. Designed to prevent unauthorized or accidental access to the inner surfaces of the vacuum.
4. 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.
5. Airborne radioactivity levels should be monitored when a vacuum cleaner is used in a High Contamination Area.
6. A nuclear safety review should be performed and documented prior to the use of a vacuum cleaner for fissile material.

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Appendix 4A, Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements

The data presented in Appendix 4A are to be used for identifying accountable sealed radioactive sources and radioactive material areas as those terms are defined in the glossary of this Manual, establishing the need for radioactive material area posting in accordance with Article 236, and establishing the need for radioactive material labeling in accordance with Article 412 [835. Appendix E.1]. [RPP # 278]

Nuclide	Activity (μCi)	Nuclide	Activity (μCi)	Nuclide	Activity (μCi)
Ac-227	4.2E+00	H-3	1.5E+08	Re-184m	1.5E+02
Ag-105	3.3E+06	Hf-172	7.3E+04	Re-186m	3.4E+05
Ag-108m	1.8E+01	Hf-175	3.0E+06	Rh-101	8.7E+05
Ag-110m	2.2E+01	Hf-178m	8.7E+03	Rh-102	3.0E+05
Al-26	1.5E+01	Hf-181	3.4E+02	Rh-102m	6.4E+05
Am-241	7.2E+01	Hf-182	7.5E+03	Ru-103	4.4E+02
Am-242m	1.1E+02	Hg-194	5.2E+04	Ru-106	2.5E+02
Am-243	7.3E+01	Hg-203	4.9E+02	S-35	2.4E+06
As-73	5.3E+02	Ho-166m	2.1E+01	Sb-124	9.1E+01
Au-195	4.8E+02	I-125	3.5E+02	Sb-125	6.7E+01
Ba-133	5.1E+01	I-129	1.8E+02	Sc-46	6.2E+01
Be-10	1.4E+05	In-114m	7.7E+02	Se-75	6.3E+01
Be-7	3.1E+03	Ir-192	1.3E+02	Se-79	8.7E+05
Bi-207	1.7E+01	Ir-192m	1.4E+05	Si-32	4.9E+04
Bi-208	1.5E+01	Ir-194m	2.7E+01	Sm-145	2.4E+06
Bi-210m	1.2E+03	K-40	2.7E+02	Sm-146	4.0E+02
Bk-247	6.0E+01	La-137	2.7E+05	Sm-151	2.5E+05

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Appendix 4A. Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements. (cont.)

Nuclide	Activity (μCi)	Nuclide	Activity (μCi)	Nuclide	Activity (μCi)
Bk-249	2.7E+04	Lu-173	1.8E+06	Sn-113	3.1E+02
C-14	4.6E+06	Lu-174	9.3E+05	Sn-119m	3.3E+02
Ca-41	9.3E+06	Lu-174m	1.0E+06	Sn-121m	8.1E+05
Ca-45	1.1E+06	Lu-177m	5.8E+01	Sn-123	1.3E+04
Cd-109	1.6E+02	Md-258	6.1E+02	Sn-126	1.8E+02
Cd-113m	2.0E+04	Mn-53	7.5E+07	Sr-85	1.2E+02
Cd-115m	1.0E+04	Mn-54	6.5E+01	Sr-89	4.8E+05
Ce-139	2.4E+02	Mo-93	7.7E+01	Sr-90	3.5E+04
Ce-141	2.4E+03	Na-22	1.9E+01	Ta-179	9.3E+06
Ce-144	1.4E+03	Nb-91	6.9E+01	Ta-182	7.3E+01
Cf-248	4.4E+02	Nb-91m	3.6E+02	Tb-157	2.5E+03
Cf-249	5.5E+01	Nb-92	1.8E+01	Tb-158	9.0E+04
Cf-250	1.2E+02	Nb-93m	4.4E+02	Tb-160	1.2E+02
Cf-251	5.3E+01	Nb-94	2.3E+01	Tc-95m	1.3E+02
Cf-252	5.2E+00	Nb-95	3.4E+02	Tc-97	8.1E+01
Cf-254	1.2E+02	Ni-59	3.2E+06	Tc-97m	3.5E+02
Cl-36	5.2E+05	Ni-63	1.3E+06	Tc-98	2.5E+01
Cm-241	1.0E+05	Np-235	1.1E+02	Tc-99	8.4E+05
Cm-242	6.2E+02	Np-236	2.1E+01	Te-121m	1.8E+02
Cm-243	4.8E+01	Np-237	4.9E+01	Te-123m	2.8E+02

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Appendix 4A. Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements. (cont.)

Nuclide	Activity (μCi)	Nuclide	Activity (μCi)	Nuclide	Activity (μCi)
Cm-244	1.5E+02	Os-185	1.3E+02	Te-125m	4.4E+02
Cm-245	5.0E+01	Os-194	6.4E+04	Te-127m	8.0E+02
Cm-246	1.0E+02	Pa-231	3.0E+01	Te-129m	2.3E+03
Cm-247	8.5E+01	Pb-202	1.9E+05	Th-228	8.4E+01
Cm-248	2.8E+01	Pb-205	9.1E+01	Th-229	3.1E+01
Cm-250	5.4E+00	Pb-210	9.2E+01	Th-230	5.4E+00
Co-56	3.9E+01	Pd-107	9.3E+06	Th-232	9.3E+01
Co-57	2.3E+02	Pm-143	1.3E+02	Ti-44	1.5E+02
Co-58	1.3E+02	Pm-144	2.9E+01	Tl-204	2.2E+04
Co-60	1.7E+01	Pm-145	2.6E+02	Tm-170	8.4E+03
Cs-134	2.6E+01	Pm-146	4.4E+01	Tm-171	2.8E+04
Cs-135	1.3E+06	Pm-147	7.7E+05	U-232	1.0E+02
Cs-137	6.0E+01	Pm-148m	1.0E+02	U-233	3.9E+02
Dy-159	1.0E+07	Po-209	6.3E+03	U-234	2.9E+02
Es-254	6.3E+01	Po-210	1.2E+03	U-235	6.7E+01
Es-255	8.8E+03	Pt-193	8.7E+07	U-236	3.1E+02
Eu-148	1.1E+06	Pu-236	2.0E+02	U-238	3.5E+02
Eu-149	1.1E+07	Pu-237	3.3E+02	V-49	1.0E+08
Eu-152	3.1E+01	Pu-238	9.0E+01	W-181	1.0E+03
Eu-154	3.1E+01	Pu-239	8.4E+01	W-185	3.9E+06

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Appendix 4A. Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements. (cont.)

Nuclide	Activity (μCi)	Nuclide	Activity (μCi)	Nuclide	Activity (μCi)
Eu-155	3.6E+02	Pu-240	8.4E+01	W-188	6.3E+04
Fe-55	2.9E+06	Pu-241	4.6E+03	Y-88	3.3E+01
Fe-59	1.9E+02	Pu-242	8.7E+01	Y-91	5.0E+04
Fe-60	8.1E+03	Pu-244	9.0E+01	Yb-169	5.5E+02
Fm-257	5.1E+02	Ra-226	2.2E+02	Zn-65	1.1E+02
Gd-146	5.1E+05	Ra-228	1.5E+03	Zr-88	1.1E+02
Gd-148	9.0E+01	Rb-83	9.1E+01	Zr-93	9.3E+04
Gd-151	2.9E+06	Rb-84	2.0E+02	Zr-95	1.9E+02
Gd-153	2.1E+02	Re-183	5.3E+02		
Ge-68	5.6E+02	Re-184	2.6E+02		

Any alpha emitting radionuclide not listed above and mixtures of alpha emitters of unknown composition have a value of 10 μCi [835.Appendix E.2]. [RPP # 279]

With the exception that any type of STC has a value of 10 Ci, any radionuclide other than alpha emitting radionuclides not listed above and mixtures of beta emitters of unknown composition have a value of 100 μCi [835.Appendix E.3]. [RPP # 280]

Note: Where there is a combination of radionuclides in known amounts involved, derive the value for the combination as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the value otherwise established for the specific radionuclide when not in combination. If the sum of such ratios for all radionuclides in the combination exceeds unity (1), then the accountability criterion has been exceeded [835.Appendix E Note]. [RPP # 281]

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**CHAPTER 5
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PART 1 External Dosimetry**511 Requirements**

1. *For the purpose of monitoring individual exposures to external radiation, personnel dosimeters shall [835.402(a)] be provided to and used by:*
 - a. *Radiological workers who, under typical conditions, are likely to receive one or more of the following:*
 - *An effective dose to the whole body of 0.1 rem (0.001 Sv) or more in a year [RPP # 80; HSD F.5];*
 - *An equivalent dose to the skin or to any extremity of 5 rems (0.05 Sv) or more in a year [RPP # 81; HSD F.5];*
 - *An equivalent dose to the lens of the eye of 1.5 rems (0.015 Sv) or more in a year [RPP # 82; HSD F.5].*
 - b. *Declared pregnant workers who are likely to receive from external sources an equivalent dose to the embryo/fetus in excess of 10 percent of the applicable limit at Table 2-1; [RPP # 83]*
 - c. *Occupationally exposed minors likely to receive a dose in excess of 50 percent of the applicable limits at Table 2-1 in a year from external sources; [RPP # 84]*
 - d. *Members of the public entering a controlled area likely to receive a dose in excess of 50 percent of the limit at Article 214 in a year from external sources; and [RPP # 85]*
 - e. *Individuals entering a high or very high radiation area. [RPP # 86]*
2. *The contractor shall ensure that Department of Energy Laboratory Accreditation Program (DOELAP)-accredited neutron dosimetry is provided to and used whenever an individual is likely to meet or exceed any of the criteria in 10 CFR 835.402(a), and 10 percent or more of the dose is likely to be due to neutron exposure. The Hanford Combination Neutron Dosimeter (HCND) shall be used for personnel who are expected to receive neutron exposure on a regular basis. The contractors may use the Hanford Standard Dosimeter (HSD) for limited monitoring of neutrons where the anticipated neutron dose as read (prior to correction) is less than 100 mrem. When the HSD is to be used for limited monitoring of neutron dose, the contractor shall document the anticipated neutron energy, the likelihood of neutron energy variance, and any correction factors used to adjust neutron dose in a technical assessment/basis [HSD F.6].*
3. Dosimeters should be issued only to personnel formally instructed in their use and should be worn only by those to whom the dosimeters were issued.
4. To minimize the number of personnel in the dosimetry program, the issuance of dosimeters is discouraged to other than personnel entering Radiation Areas, High Radiation Areas or Radiological Buffer Areas where there is a potential for external exposure. Although issuing dosimeters to personnel who are not occupationally exposed to radiation can appear as a conservative practice, it creates the impression that the wearers are occupationally exposed to radiation.

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5. Personnel 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. *The following elements of the external dosimetry program shall be consistent between Hanford site contractors as members of the Hanford Radiological Control Forum [HSD F.1]:*
 - *The issuance, use and return of dosimeters by individuals.*
 - *The prescribed wear location for dosimetry.*
 - *The use of supplemental dosimeters.*
7. 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.
8. Reserved.
9. *The contractor shall ensure that individuals do not wear dosimeters issued by their organization while being monitored by dosimetry at another facility unless authorized by the resident radiological control manager. The contractor shall also ensure that individuals do not knowingly expose their dosimeters to non-occupational sources of radiation or to high temperatures [HSD F.2].*
 - a. *The contractor shall ensure that individuals notify line management and the Radiological Control organization of pending off-site work involving expected occupational exposures to radiation or radioactive materials. If such work is authorized, records of off-site dose shall be submitted for inclusion into the individual's radiation exposure monitoring records within 30 days upon receipt. [HSD F.7]*
 - b. For work at offsite facilities that will involve occupational exposure to radiation or radioactive materials the Radiological Control organization may specify the use of a special Hanford dosimeter during the work.
10. A person 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. Reentry of the person into Radiological Buffer Areas should not be made until a review has been conducted and management has approved reentry.
11. *The contractor shall perform a dose assessment for each instance in which a dosimeter issued to an individual becomes lost, damaged, or contaminated. This dose assessment shall become part of the individual's radiation exposure monitoring records [HSD F.4].*

512 Technical Requirements for External Dosimetry

1. *External dose monitoring programs implemented to demonstrate compliance with Article 511.1 shall [835.402(b)(1)] be adequate to demonstrate compliance with the dose limits in Chapter 2. The external dose monitoring program shall [835.402(b)(1)] be accredited in accordance with the DOE Laboratory Accreditation Program for Personnel Dosimetry. A technical basis document*

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shall [835.402(b)(1)] be developed and maintained for the external dosimetry program. [RPP # 87] The TOC Contractor shall participate in the development and maintenance of a Hanford site-wide external dosimetry technical basis document. The TOC contractor's external dosimetry program shall be performed in accordance with this technical basis document. Changes to the external dosimetry technical basis document shall be reviewed and endorsed by each Hanford contractor who conducts activities in accordance with an approved Radiation Protection Program [HSD F.3]. Personnel external dosimeters include but are not limited to TLDs. For the context of this Manual, reference to the external dosimetry technical basis document pertains to information to be contained in the "Hanford External Dosimetry Technical Basis Manual" (HNF-55634) or to the "Hanford External Dosimetry Quality Manual" (PNL-MA-859). The contractor shall utilize only external dosimetry programs which have been DOELAP accredited through RL and in accordance with the site-wide external dosimetry technical basis document [HSD F.8].

2. The technical basis document should also address dosimeters monitoring radiation outside the scope of DOELAP, such as dosimetry associated with high-energy accelerators, as applicable.
3. Facilities should participate in intercomparison studies for external dosimetry programs.
4. ***Personnel exposures to the skin, lens of the eye and extremities shall [835.702(c)(3)] be reported separately when monitored. [RPP # 164 - 166]***
5. Multiple whole body dosimetry should be worn to assess the Effective Dose (ED) from external radiation when either of the following two criteria are met:
 - a. The calculated ED is expected to exceed the deep + neutron equivalent dose measured by the reference dosimeter by more than 30 percent, and is expected to exceed 100 mrem; or
 - b. The calculated ED is expected to exceed the deep + neutron equivalent dose measured by the reference dosimeter by more than 100 mrem.

ED should be calculated using the method and compartment weighting factors described in the "Hanford External Dosimetry Technical Basis Manual (HNF-55634). The above criteria do not preclude the use of multiple dosimetry if deemed appropriate (e.g. because of uncertainties in worker movement or radiation field strength.)

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. Supplemental dosimeters should be issued to personnel prior to entry into a High Radiation or Very High Radiation Area (see Article 334 for entry requirements); when a person could exceed 10 percent of an administrative control level from external radiation in one work day; 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.

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3. Supplemental dosimeters should be read periodically while in use in High Radiation or Very High Radiation Areas and should not be allowed to exceed 75 percent of full scale.
4. Supplemental pocket or electronic dosimeters used for exposure control should be worn outside the personal 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. In other situations the supplemental or electronic dosimeter may be worn inside the personal protective clothing unless directed otherwise by Project/Activity Radiological Control.
5. The energy dependence of supplemental dosimeters, particularly to low-energy beta radiation, should be considered in determining their applicability.
6. Use of electronic dosimeters is encouraged for entry into High Radiation Areas or when planned doses greater than 100 mrem in one 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.

514 Area Monitoring Dosimeters

Establishment and maintenance of a comprehensive area monitoring program minimizes the number of areas requiring the issuance of personnel dosimeters and demonstrate that doses outside Radiological Buffer 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 should be used to record and document radiation levels in routinely occupied areas adjacent to areas where radiation or operations with radiation exist. This monitoring requirement does not apply when the radiation arises solely from low-energy beta sources (e.g., Carbon-14 or tritium).
2. Area monitoring dosimeter results should be used to support dosimetry investigations where personnel express concerns about their work environments and exposure to ionizing radiation.
3. Area monitoring dosimeters should be used in Radiologically Controlled Areas to supplement existing monitoring programs and to provide data in the event of an emergency.

515 Nuclear Accident Dosimeters

1. *Installations possessing sufficient quantities of fissile material to potentially constitute a critical mass, such that the excessive exposure of individuals to radiation from a nuclear accident is possible, shall [835.1304(a)] provide nuclear accident dosimetry for those individuals. [RPP # 255]*
2. *Nuclear accident dosimetry shall [835.1304(b)] include the following:*
 - a. *A method to conduct initial screening of individuals involved in a nuclear accident to determine whether significant exposures to radiation occurred; [RPP # 256]*
 - b. *Methods and equipment for analysis of biological materials; [RPP # 257]*

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c. A system of fixed nuclear accident dosimeter units; and [RPP # 258]

d. Personal nuclear accident dosimeters. [RPP # 259]

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 percent.
 - 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 percent.
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 percent.
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.
6. Placement criteria for Hanford Nuclear Accident Dosimeter is provided in the Hanford External Dosimetry Program Technical Basis Document (HNF-55634).

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PART 2 Internal Dosimetry

521 Requirements

1. *For the purpose of monitoring individual exposures to internal radiation, internal dosimetry programs (including routine bioassay programs) shall [835.402(c)] be conducted for:*
 - a. *Radiological workers who, under typical conditions, are likely to receive a committed effective dose of 0.1 rem (0.001 Sv) or more from all occupational radionuclide intakes in a year; [RPP # 89]*
 - b. *Declared pregnant workers likely to receive an intake or intakes resulting in an equivalent dose to the embryo/fetus in excess of 10 percent of the limit stated at Table 2-1; [RPP # 90]*
 - c. *Occupationally exposed minors who are likely to receive a dose in excess of 50 percent of the applicable limit stated at Table 2-1 from all radionuclide intakes in a year; or [RPP # 91]*
 - d. *Members of the public entering a radiologically controlled area likely to receive a dose in excess of 50 percent of the limit stated in Article 214 from all radionuclide intakes in a year. [RPP # 92]*
2. *The estimation of internal dose shall [835.209(b)] be based on bioassay data rather than air concentration values unless bioassay data are:*
 - a. *unavailable;*
 - b. *inadequate; or*
 - c. *internal dose estimates based on air concentration values are demonstrated to be as or more accurate. [RPP # 69]*
3. Personnel 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 mrem or more.
4. Personnel 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.
5. Personnel should submit bioassay samples, such as urine or fecal samples, and participate in bioassay monitoring, such as whole body or lung counting, at the frequency required by the bioassay program.
6. Personnel should be notified of positive bioassay results and the results of dose assessments and subsequent refinements. Dose assessment results should be provided in terms of rem or mrem.
7. Bioassay monitoring to satisfy the requirements may be routine, periodic monitoring, or may be bioassay conducted at the end of the work assignment if the work period is shorter than the routine bioassay period.

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8. In general, overly conservative use of bioassay monitoring (at levels less than those indicated above), is discouraged; however, if the above guidance does not appear to adequately apply to a particular task, the company internal dosimetry organization should be contacted for specific guidance.
9. Broad scope bioassay programs should be established for rotational worker groups (e.g., Health Physics Technicians) potentially exposed to many radionuclides or mixtures of radionuclides in a year because of rotational work assignments.
 - Participation in the broad scope bioassay program should be based on consideration of all work assignments expected in a year, not on task-specific RWPs.
 - For a worker in a broad scope program, ending-work bioassay measurements are not required until the worker transfers out of rotational work assignments or terminates employment.

522 Technical Requirements for Internal Dosimetry

Internal dose monitoring programs implemented to demonstrate compliance with Article 521.1 a, b, c and d shall [835.402(d)(1)] be adequate to demonstrate compliance with the dose limits established in Table 2-1. The internal dose monitoring programs shall [835.402(d)(1)] be accredited in accordance with DOE Laboratory Accreditation Program for Radiobioassay. [RPP # 93]

WRPS shall utilize only direct and indirect radiobioassay programs which have been DOELAP accredited through RL [HSD G.7].

1. *A technical basis document shall [835.402(d)(1)] be developed for the internal dosimetry program. [RPP # 93]. The contractor's internal dosimetry program shall be performed in accordance with the Hanford site-wide internal dosimetry technical basis document [HSD G.2]. Changes to the internal dosimetry technical basis document shall be reviewed by each Hanford contractor who conducts activities in accordance with an approved Radiation Protection Program [HSD G.1].* For the context of this Manual, reference to the Internal Dosimetry Technical Basis document pertains to information contained in the current versions of:
 - Hanford Internal Dosimetry Project Manual (HNF-55719)
 - Methods and Models of the Hanford Internal Dosimetry Program (HNF-55720)
 - TOC Approved Annual Limits on Intake (ALI) Values (TOC-1501-FACT-0314)
2. *The contractor shall ensure that appropriate bioassay monitoring methods, analytical procedures, and frequencies for the collection of bioassay samples, such as urine or fecal samples, and appropriate participation in bioassay monitoring, such as whole body or lung counting, are established for personnel who are likely to receive intakes in a calendar year resulting in a committed effective dose greater than 100 mrem [HSD G.3]. Baseline bioassay monitoring of personnel who are likely to receive intakes resulting in a committed effective dose greater than 100 mrem shall [835.402(c)(1)] be conducted before they begin work that may expose them to internal radiation exposure. [RPP # 89]*
3. *Routine bioassay monitoring methods and frequencies shall [835.402(c)(1); HSD G.1] be established for personnel who are likely to receive intakes resulting in a committed effective dose*

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greater than 100 mrem. The technical basis for the methods and frequency of bioassay monitoring shall [10 CFR 830.120(c)(1)(iv)] be documented. [RPP # 89]

4. ***Management shall [835.402(c)(1)]; HSD G.1] require termination bioassay monitoring when a person who participated in the routine bioassay program terminates employment or concludes work involving the potential for internal exposure. The number of persons failing to achieve this monitoring should be reviewed periodically and should be used to determine whether further efforts to get cooperation are warranted. [RPP # 89]***
5. ***Bioassay analyses shall [835.402(c)(1)] also be performed when any of the following occurs:***
 - a. ***Facial or nasal contamination is detected that indicates a potential for internal contamination***
 - b. ***Airborne monitoring indicates the potential for intakes exceeding 100 mrem committed effective dose***
 - c. ***When directed by the Radiological Control organization. [RPP # 89]***
6. 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.
7. A preliminary assessment of any intakes detected should be conducted prior to permitting an employee to return to radiological work.
8. Internal dosimetry program personnel should use radionuclide standards from or traceable to the National Institute of Standards and Technology (NIST).
9. Internal dosimetry program personnel should participate in the conduct of intercomparison studies and should use the "DOE Phantom Library."

523 Technical Requirements for Dose Assessment

1. ***Interpretation of bioassay results and subsequent dose assessments shall [835.702(c)(4)(iii)] include the following:***
 - a. ***Characteristics of the radionuclide(s), such as chemical and physical form [HSD G.4.a];***
 - b. ***Bioassay results and the individual's previous exposure history pertinent to the dose assessment[HSD G.4.b];***
 - c. ***Exposure information, such as route of intake and time and duration of exposure [HSD G.4.c];***
 - d. ***Biological models used for dosimetry of radionuclides [HSD G.4.d];***
 - e. ***Models to estimate intake or deposition and to assess dose and; [RPP # 169; HSD G.4.e]***
 - f. Intradepartmental coordination between the Radiological Control organization and the medical organization for doses that may require medical intervention. (The Hanford Internal Dosimetry

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project should be included in interdepartmental coordination for evaluation of doses that require medical intervention.)

2. *The contractor shall use air monitoring data to assess and assign internal dose when:*
 - a. *The accumulated exposures to airborne radioactivity exceed 40 DAC-hrs in a calendar year, and*
 - b. *The minimum detectable dose for the applicable bioassay technology available at Hanford exceeds the anticipated dose (committed effective dose) from these exposures [HSD G.5.b].*
3. *The contractor shall develop and maintain a technical basis document for the collection, analysis, assessment of air monitoring data used to assess and assign internal dose [HSD G.6].*

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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. The respiratory protection program is implemented in accordance with TFC-ESHQ-S_IH-C-05, "Respiratory Protection".

531 Requirements

Use of respiratory protection should be minimized by implementing engineering controls and work practices to contain radioactivity at the source. Engineering controls should be designed to control radioactive materials at the source, so that respiratory protection can be reduced.

Radiological Work Permits should identify the minimum level of respiratory protection required for radiological purposes, when applicable.

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. The planning stages for work in hot environments should address heat stress controls. Recommended work time limits and use of body cooling devices should be considered to reduce heat stress. Job supervisors should inform their personnel of heat stress precautions prior to work on job assignments in hot environments. If a person begins to feel symptoms of heat illness, the person 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

1. Half-face respirators should not be used for protecting workers from potential airborne radioactive materials. Half-face respirators are undesirable because their seal with the face is more likely to fail than with full-face respirators, particularly during heavy work.

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PART 4 Handling Radiological 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. Hanford contractors should use a standardized form for recording skin contamination data to assure consistency across the site.
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.
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 mrem.
6. Personnel 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. Personnel 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 mrem) 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. Assessments should be conducted in accordance with Appendix 2B and, 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 in accordance with National Council on Radiation Protection and Measurements Report Number 65. Medical treatment of injuries takes precedence over radiological considerations.
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;

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- e. Initiation of appropriate bioassay monitoring; and
 - f. Determination of need for work restrictions.
3. An injured person should be counseled promptly on the medical and radiological implications resulting from contaminated wounds that result in internal doses greater than 2 percent of the Table 2-1 limits. Counseling should be performed by senior radiological control and medical professionals.

543 Exposures to Airborne Radioactivity

Potential intakes of radioactive material are indicated when personnel 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 mrem, the following actions should be taken:

1. Identify personnel 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; and
6. Evaluate dose prior to permitting the worker to return to radiological work.

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PART 5 Radiological Monitoring and Surveys

551 Requirements

1. *Monitoring of individuals and areas shall [835.401(a)] be performed to:*
 - a. *Demonstrate compliance with the requirements of 10 CFR 835; [RPP # 70]*
 - b. *Document radiological conditions; [RPP # 71]*
 - c. *Detect changes in radiological conditions; [RPP # 72]*
 - d. *Detect the gradual buildup of radioactive material; [RPP # 73]*
 - e. *Verify the effectiveness of engineered and administrative controls in containing radioactive material and reducing radiation exposure; and [RPP # 74]*
 - f. *Identify and control potential sources of individual exposure to radiation and/or radioactive material. [RPP # 75]*
2. Monitoring should be performed only by trained and qualified personnel.
3. Surveys for radiation, contamination and airborne radioactive materials should be performed as specified in technical work documents and Radiological Work Permits.
4. The TOC should perform and document a review of the adequacy of sampling and monitoring systems 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 and equipment used for monitoring should be readily available and shall [10 CFR 835.401(b)] be:*
 - a. *Periodically maintained and calibrated on an established frequency; [RPP # 76]*
 - b. *Appropriate for the type(s), levels and energies of the radiation(s) encountered; [RPP # 77]*
 - c. *Appropriate for the existing environmental conditions; and [RPP # 78]*
 - d. *Routinely tested for operability on a specified frequency commensurate with their application and design. [RPP # 79]*

Performance testing requirements for portable radiological survey instruments are identified in ANSI N323A-1997. Compensatory actions shall [835.401(b)(4)] be established to ensure proper instrument performance when performance tests are not feasible, such as with instruments used to measure neutrons or tritium. [RPP # 79]
6. Assessment of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries.

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7. Surveys should be performed before, during and at the completion of work that has the potential for causing changes in levels of radiation and radioactivity.
8. *Survey frequencies shall [835.401(a), 835.1102(a)] be established based on potential radiological conditions, probability of change in conditions and area occupancy factors. [RPP # 70 & 229]*
9. Monitoring results should be reviewed by the cognizant radiological supervisor or their appointed designee. The review should 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.
11. Monitoring results should be made available to line management and used in support of pre- and post-job evaluations, 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.

552 Radiation Exposure Surveys

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 for 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. The process described in Article 113.3 should be used when modifying to a lesser frequency.
 - a. Daily, in office space located in Radiological Buffer Areas where the potential exists for external radiation exposure;
 - b. Weekly, in routinely occupied Radiological Buffer Areas established for exposure control and Radiation Areas, with the exception of inactive Single Shell Tank Farms which should be surveyed monthly;
 - c. Upon initial entry and weekly during continuing operations in High Radiation Areas;
 - d. Weekly, for accessible, operating HEPA-filtered ventilation units;
 - e. Weekly, for temporary Radiation Area boundaries to ensure that radiation areas do not extend beyond posted boundaries;
 - f. Monthly, or upon entry, if entries are less frequent than monthly for Radioactive Material Areas; and
 - g. Monthly, for potentially contaminated ducts, piping and hoses in use outside radiological facilities.

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2. Performance of radiation surveys 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.
3. Surveys should be conducted whenever operations are being performed that might result in personnel 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.
4. Radiation monitoring instruments should be capable of measuring ambient radiation dose rates for the purpose of controlling radiation exposures.

553 Area Radiation Monitors

1. In addition to the requirements 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 entering remote locations.
2. Area radiation monitors should not be substituted for radiation exposure surveys in characterizing a workplace.
3. The need 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 at least quarterly to verify audible alarm system operability and audibility under ambient working conditions and operability of visual alarms when so equipped.
5. If installed instrumentation is removed from service for maintenance or calibration, a radiation monitoring program providing at least equal detection capability should be maintained, consistent with the potential for unexpected increases in radiation dose rates.
6. ***The contractor shall ensure that where an area radiation monitor is incorporated into a safety interlock system, the circuitry shall be such that a failure of the monitor either prevents entry into the area or prevents operation of the radiation-producing device [HSD H.3].***

554 Contamination Surveys

1. In addition to the requirements of Article 551, routine 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 for 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. The process described in Article 113.3 should be used when modifying to a lesser frequency.
 - a. Reserved;

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- b. Prior to transfer of equipment and material from highly contaminated 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 established for contamination control;
 - e. Daily, in lunch rooms or eating areas near Radiological Buffer Areas established for contamination control;
 - f. Weekly, in routinely occupied Radiological Buffer Areas established for contamination control, with the exception of inactive Single Shell Tank Farms which should be surveyed monthly;
 - g. Weekly, or upon entry if entries are less frequent, in contamination areas or other areas where materials having removable contamination levels exceeding Table 2-2 values are handled or stored, with the exception of inactive Single Shell Tank Farms which should be surveyed monthly;
 - h. Weekly, or upon entry if entries are less frequent, where contamination boundaries or postings are located, with the exception of inactive Single Shell Tank Farms which should be surveyed monthly;
 - i. 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; and
 - j. After a leak or spill of radioactive materials.
2. ***Surveys for the release of materials shall [835.1101; DOE O 458.1] be conducted in accordance with Articles 421 and 422. [RPP # 224]***
 3. Contamination surveys should incorporate techniques to detect both removable and fixed contamination.
 4. Items with inaccessible surfaces which were located in known or suspected contamination areas and had the potential to become contaminated at levels likely to exceed Table 2-2 values should be treated as potentially contaminated and subject to administrative controls unless the items are dismantled and monitored or special survey techniques are used to survey all surfaces.
 5. The requirements for assessing representative samples of bulk material, such as sand, sweeping compounds or plate steel, which are not suitable for normal loose and fixed contamination level assessment techniques, are specified in DOE O 458.1.
 6. Swipe surveys for removable contamination should be reported in units of disintegrations per minute per 100 cm² (dpm/100 cm²). For swipe surveys of small items covering less than 100 cm², the results should be reported in units of dpm per area swiped. If contamination levels exceed the range of the available count rate meters, the swipes should be analyzed with an appropriate dose rate meter and the results should be recorded in units of millirad or rad per hour.

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7. 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 Buffer Areas. If an evaluation indicates that an area wiped is contaminated, a thorough contamination swipe survey should be performed.
8. Areas identified as either contaminated with, or having the potential for being contaminated with, highly radioactive particles (hot particles) should be surveyed weekly. These areas should be surveyed at least daily during periods of work that may result in the generation of hot particles. Special swipe techniques to collect hot particles, such as tape and large area wipes, should be used.

555 Airborne Radioactivity Monitoring

1. In addition to the requirements of Article 551, air monitoring equipment should be used in situations where airborne radioactivity levels can fluctuate and early detection of airborne radioactivity could prevent or minimize inhalation of radioactivity by personnel. 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.
2. ***Monitoring of airborne radioactivity shall [835.403(a)] be performed:***
 - a. ***Where an individual is likely to receive an exposure of 40 or more DAC-hours in a year; or [RPP # 95]***
 - b. ***As necessary to characterize the airborne radioactivity hazard where respiratory protective devices for protection against airborne radionuclides have been prescribed. [RPP # 96]***
3. ***Real-time air monitoring shall [835.403(b)] be performed as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material. [RPP # 97]*** Real-time air monitoring equipment should be installed where unexpected increases in airborne radioactivity levels, should they occur, are likely to result in an exposure exceeding 40 DAC-hours in one week. Such exposures could result from a breakdown of engineering controls or improper establishment of boundaries during work that creates airborne radioactivity.
4. Air sampling equipment should be positioned to measure air concentrations to which persons are exposed. If this cannot be achieved, a program of personal breathing-zone air sampling should be initiated.
5. Air monitoring equipment should be routinely calibrated and maintained on an established frequency. Continuous air monitors should be capable of measuring 1 DAC when averaged over eight hours (8 DAC-hours) under laboratory conditions. ANSI N323C-2009 indicates that air flow meters, differential pressure indicators, and other devices used to determine volumetric flow rates of air samplers and monitors should be calibrated to within ± 15 percent of the conventionally true value.
6. ***Continuous air monitoring equipment required by Article 555.3 shall [835.403(b)] have alarm capability and sufficient sensitivity to alert personnel that immediate action is necessary in order to minimize or terminate inhalation exposures. [RPP # 97]***

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7. ***The proper operation of continuous air monitoring equipment shall [835.401(b)(4)] be verified daily by performing an operational check. Operational checks should include positive airflow indication, non-zero response to background activity, and internal check sources or 60 Hz electronic checks when available. Continuous air monitoring equipment shall [835.401(b)(4)] be verified weekly by checking for instrument response with a check source or with ambient levels of radon and thoron daughters. [RPP # 79]***
8. 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.
9. 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.

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PART 6 Instrumentation and Calibration

561 Standardization

Standardization on the use of commercially available radiological instrumentation in the DOE is highly encouraged. The Hanford Instrument Evaluation committee will provide recommendations for the selection of portable instrumentation used at Hanford.

562 Inspection, Calibration and Performance Tests

1. **Radiological instruments and equipment shall [835.401(b)(1)] be periodically maintained and calibrated on an established frequency. [RPP # 76]** Radiological instruments and equipment should be used only to measure the radiation for which their calibrations are valid. **The contractor shall ensure that calibration of radiological measurement instruments/dosimetry is performed in accordance with one or more of the following standards, as applicable [HSD H.2]:**

- **ANSI N323-1978, “Radiation Protection Instrumentation Test and Calibration – Description” [HSD H.2].**
- **ANSI N323A-1997, “Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments” [HSD H.2].**
- **ANSI N323B-2003, “Radiation Protection Instrumentation Test and Calibration, Portable Survey Instrumentation for Near Background Operation” [HSD H.2].**
- **ANSI N323C-2009, “Radiation Protection Instrumentation Test and Calibration - Air Monitoring Instruments” [HSD H.2].**
- **ANSI N323D-2002, “Installed Radiation Protection Instrumentation” [HSD H.2].**
- **ANSI N13.1-1999, “Sampling and Monitoring Releases of Airborne Radioactive Substances from Stacks and Ducts of Nuclear Facilities” [HSD H.2].**
- **ANSI N13.11-2009, “Personnel Dosimetry Performance - Criteria for Testing” [HSD H.2].**
- **ANSI N13.27-1992, “Performance Specifications for Pocket-Sized Alarming Dosimeters/Ratemeters” [HSD H.2].**
- **ANSI N13.32-2008, “Performance Testing of Extremity Dosimeters” [HSD H.2].**

Calibrations shall use National Institute of Standards and Technology (NIST) traceable sources, or equivalent traceable sources [HSD H.1].

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. **Pocket and electronic dosimeters and area radiation monitors shall [835.401(b)] be calibrated in accordance with Article 562.1. [RPP # 76]**
4. **The effects of environmental conditions, including interfering radiation, on an instrument shall [835.401(b)(3)] be known prior to use. [RPP # 78]**
5. **Functional tests shall [835.401(b)(4)] be used to assess instrumentation designs that include alarms or that involve a process control. A functional test should be developed to periodically test all components involved in an alarm or trip function. [RPP # 79]**

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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. Instruments should bear a label or tag with the date of calibration and date calibration expires to verify its calibration status.
8. ***The Radiological Control organization shall evaluate the potential radiological consequences and document any corrections to the original monitoring results upon determination of the use of an out-of-calibration or failed radiation measurement instrument [HSD H.4].*** The Radiological Control organization should review surveys performed with the instrument while it was out of calibration.

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 shall [835.401(b)] 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. [RPP # 76]***

564 Calibration Facilities

1. ***Calibration facilities shall [835.703(d)] perform inspections, calibrations, performance tests, calibration equipment selection and quality assurance in accordance with the recommendations of ANSI N323A-1997 and take the following actions:***
 - a. Locate activities in a manner to minimize radiation exposure to operating personnel and to personnel in adjacent areas;
 - b. Minimize sources of interference, such as backscatter and non-ionizing radiation, during the calibration of instrumentation and correct for interferences as necessary;
 - c. Operate in accordance with the referenced standards; and
 - d. ***Generate records of calibration, functional tests, and maintenance. [RPP # 183]***
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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TRAINING AND QUALIFICATION
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PART 1 General Requirements

611 Purpose

This chapter establishes the requirements to ensure that personnel have the training to work safely in and around radiological areas and to maintain their individual radiation exposure and the radiation exposures of others As Low As Reasonably Achievable (ALARA). *The Hanford Radiological Control Forum shall ensure that radiation safety training programs, including course content, examinations, performance demonstrations, and requalification, for General Employee Radiological Training (GERT), Radiological Worker I (RWI), and Radiological Worker II (RWII), will be sufficiently consistent to maintain reciprocity of this training between contractors for core training materials and Hanford site-specific training [HSD I.4]. The contractor shall ensure that individuals meet the applicable minimum radiation safety training requirements in Table 6-1 for access to areas requiring control for radiological health and safety [I.5].* Training requirements in this chapter apply to personnel entering DOE Hanford area sites.

Site radiological safety training provides individuals with knowledge and skills common to all facilities. Each facility is responsible for facility specific training necessary for ensuring compliance with 10 CFR 835.103 and 10 CFR 835.901(c).

Individuals responsible for developing and implementing measures necessary for ensuring compliance with the requirements of this manual shall [835.103] have the appropriate education, training, and skills to discharge these responsibilities. [RPP # 38 and HSD I.1] At a minimum, this includes those individuals filling the following positions:

- *Health Physics Technicians [HSD I.1]*
- *Health Physics Technician Supervisors [HSD I.1]*
- *Radiological Control Managers [HSD I.1]*
- *Radiological Engineers [HSD I.1]*
- *Radiological Control Technical Support Staff [HSD I.1]*
- *Designated Radiological Control Senior ALARA Committee Members [HSD I.1]*
- *Radiological Assessors [HSD I.1]*
- *Line managers responsible for radiological work activities [HSD I.1]*
- *Specialized radiological workers as specified in the Radiological Control Standard (e.g., containment installers, containment inspectors) [HSD I.1].*

612 Standardization

1. *The contractor shall establish and maintain radiation safety training programs that utilize DOE standardized core training material to the maximum extent practical. The contractor shall supplement the radiation safety training programs with program-specific training material [HSD I.2].*
2. Measures should be implemented to ensure that each individual's current training status could 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.

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3. Allowances may be made for individuals who have successfully completed other types of radiological control training. ***Documentation of previous training shall [835.704] include the individual's name, date of training, topics covered, and name of the certifying official. [RPP # 184]*** 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, should be completed. 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.
5. ***The Hanford Radiological Control Forum shall ensure that radiation safety training programs, including course content, examinations, performance demonstrations, and re-qualification, for General Employee Radiological Training (GERT), Radiological Worker I (RWI), and Radiological Worker II (RWII), will be sufficiently consistent to maintain reciprocity of this training between contractors for core training materials and Hanford site-specific training [HSD I.4].***

613 Requirements

1. ***Radiation safety training shall [835.901(c)] 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; [RPP # 201]***
 - b. ***Basic radiological fundamentals and radiation protection concepts; [RPP # 202]***
 - c. ***Physical design features, administrative controls, limits, policies, procedures, alarms, and other measures implemented at the facility to manage doses and maintain doses ALARA, including both routine and emergency actions; [RPP # 203]***
 - d. ***Individual rights and responsibilities as related to implementation of the facility radiation protection program; [RPP # 204]***
 - e. ***Individual responsibilities for implementing ALARA measures; and [RPP # 205]***
 - f. ***Individual exposure reports that may be requested in accordance with Article 781. [RPP # 206]***
2. Training should address both normal and abnormal situations in radiological control.
3. General Employee Radiological training:

Each individual shall [835.901(a)] complete radiation safety training on the topics established in Article 613.1 commensurate with the hazards in the area and the required controls:

 - a. ***Before being permitted unescorted access to controlled areas; and***

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b. Before receiving occupational dose during access to controlled areas at a DOE site or facility. [RPP # 199]

General Employee Radiological training (GERT) is used by the Hanford site to satisfy this 10 CFR 835 requirement. ***GERT satisfies the orientation required by the HSD [HSD I.6 and Table 2 of the HSD]. GERT shall [835.901(e)] be completed every 24 months. [RPP # 210] Changes to the program shall [835.901(e)] be incorporated as they are identified and a decision made if retraining prior to the 24-month period is needed. [RPP #209] The Hanford Radiological Control Forum shall exercise paragraph 10 CFR 835.901(d) to the fullest extent, including the utilization of escorts for access to Radiological Controlled Areas or radiological areas for short duration visits by non-Hanford individuals in lieu of training [HSD I.7].*** In the alternate year when full retraining is not completed, Hanford General Employee training (HGET) should be completed. The time interval to conduct these activities may be extended by a period not to exceed 30 days to accommodate scheduling needs (see Article 113.1). See Part 2 of this Chapter for additional requirements for implementing GERT.

4. Radiological Worker Training

Each individual shall [835.901(b)] 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 performance demonstrations:

a. Before being permitted unescorted access to radiological areas; and

b. Before performing unescorted assignments as a radiological worker. [RPP # 200]

- Radiological Worker I and Radiological Worker II, augmented by facility specific training, are used by the Hanford site to satisfy the 10 CFR 835 requirements for unescorted access to radiological areas as specified in Table 6-1. On-the-Job training (OJT) and specialized training courses, such as for containment installation, inspection and use, are provided as appropriate to fully meet the requirements of 10 CFR 835 for performing unescorted assignments as a radiological worker. ***Radiation safety training shall [835.901(e)] be provided to individuals when there is a significant change to radiation protection policies and procedures that may affect the individual and at intervals not to exceed 24 months [835.901(e)]. [RPP # 209 & 210] Such training provided for individuals subject to the requirements of this Article shall [835.901(e)] include successful completion of an examination. [RPP # 211]*** The time interval to conduct these activities may be extended by a period not to exceed 30 days to accommodate scheduling needs (see Article 113.1). See Part 3 of this Chapter, Radiological Worker Training, for additional requirements.

5. Examinations for Radiological Worker I and II training and Radiological Control Technician qualification shall [835.901(b)] be used to demonstrate satisfactory completion of theoretical and classroom material. [RPP # 200] The contractor shall use examination and performance demonstrations, appropriate to the level of training, for initial and requalification (not to exceed 24 months) for Radiological Worker I, Radiological Worker II, and Health Physics Technician training [HSD I.3]. 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 examination process should require:

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- a. That a minimum passing score be established;
 - b. That true/false questions and open book examinations not be included;
 - c. Use of questions randomly selected from the question bank;
 - d. Acknowledgment by signature that the student participated in a post-examination review;
 - e. That competence in required skills be measured using performance-based examinations;
 - f. Remedial actions for failure to meet the minimum score;
 - g. That the question bank contain questions that test what the student is expected to remember months after the training rather than to test short-term memory of theoretical material.
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 radiological control 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, 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.
 8. Requirements for respiratory protection training are included in TFC-ESHQ-S_IH-C-05, "Respiratory Protection."
 9. Training programs developed for radiological control should meet the requirements for performance-based training and, when applicable, training accreditation.
 10. Reading and comprehension skills in the English language are generally necessary for General Employee Radiological training. The Radiological Control Manager is authorized to approve alternative temporary training methods 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. Visitor orientation and the use of trained escorts provide an alternate to training with the concurrence of the Radiological Control Manager.
 11. Training records and course documentation should meet the requirements of Article 725.

614 Qualification Standards for Health Physics Technicians

1. Qualification standards define the requirements for demonstrating completion of training. Signatures on the forms in qualification standards should document satisfactory proficiency.
2. Qualification standards from the standardized core course should be used.

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3. The qualification standards from the standardized core course should be supplemented to include site-specific elements.
4. Qualification standards for the Health Physics Technician position should include on-the-job training to provide hands-on experience directly applicable to the job.
5. Prior to performing a job function without direct supervision, a trainee with partially completed qualifications should have completed the qualifications for that task. When performing a job function for which the trainee has not been qualified, the trainee should be under direct control of qualified personnel.

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615 Oral Examination Boards

1. An Oral Examination Board should determine the initial qualification of candidates for Health Physics Technician and supervisor positions. The Oral Examination Board provides an opportunity to identify areas of weakness related to performance of Health Physics Technician duties and Supervisor functions. The Oral Examination Board also provides the opportunity to identify additional training needs to enhance Health Physics Technician and supervisor training programs.
2. The Radiological Control Manager should designate the Board members and appoint a Chairperson.
3. The Board constituted to evaluate Health Physics Technician qualification should be composed of at least three persons including a Health Physics Technician supervisor and Radiological Control staff member(s). Health Physics Technician Instructors may participate as nonvoting 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 Health Physics Technician supervisor qualification should not include peers or subordinates as voting members.

616 Instructor Training and Qualifications

1. All instructors should be qualified in accordance with the TOC'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.

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PART 2 General Employee Radiological Training

621 General Employees

- 1. *Individuals shall [835.901(a)] complete General Employee Radiological training in accordance with the requirements of Article 613.3. [RPP # 199]***
2. General Employee Radiological training should include the standardized 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.
3. Workers may challenge General Employee Radiological training standardized core knowledge requirements by passing a comprehensive examination. Challenges do not apply to the site-specific portions.
4. Reserved.
5. Additional training beyond General Employee Radiological training is necessary for unescorted entry into Radiological Buffer Areas or areas posted for radiological control other than Radiologically Controlled Areas.
6. Information may be communicated by classroom lecture, videotape or other applicable methods.
- 7. *Individuals who maintain qualifications as Radiological Worker I, Radiological Worker II, or Radiological Control Technician, satisfy the requirements for GERT [835.901(a)]. [RPP # 199]***

622 Radiological Orientation for Members of the Public

- 1. *Members of the public shall [835.901(a)] receive radiation safety training prior to being permitted unescorted access to Radiologically Controlled Areas. [RPP # 199]*** This training should 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. Members of the public should receive the same level of training as general employees in accordance with the requirements of Articles 613.3, 613.4, or 635 as applicable.
2. Information may be communicated by videotape or handout to personnel entering a site. An examination is not required.
3. Records of the orientation should be maintained. Visitor sign-in logs may be used as orientation records.
4. The orientation for continuously escorted individuals or groups should be commensurate with the areas to be visited. Records of orientation for such individuals or groups should be retained.

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PART 3 Radiological Worker Training

631 Requirements

- 1. Radiological Worker I training shall [835.901(a)] be required for unescorted entry into areas as stated in Table 6-1. [RPP # 199]**
- 2. Radiological Worker II training shall [835.901(a)] be required for unescorted entry into areas as stated in Table 6-1. [RPP # 199] Additional training is required for special job functions with radiological consequences per article 634.1 [835.901(a)].**
- Workers may challenge Radiological Worker I or II standardized 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 do not apply to the site-specific portions.
- Radiological Worker I training is not a prerequisite for Radiological Worker II training.
- Radiological Worker I and Radiological Worker II training are self-contained courses. 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.
- 6. The training shall [10 CFR 830.120(c)(1)(ii)] include tasks specific to an individual's job assignment. The level of training shall [835.901(a)] be commensurate with each worker's assignment. [RPP # 199]**

632 Radiological Worker 1

- Workers whose job assignments require access to Radiological Buffer Areas and Radiation Areas should complete DOE standardized core Radiological Worker I training and site-specific Radiological Worker I training before being permitted to enter these areas without a qualified escort.
- Radiological Worker I training should use the DOE standardized core course training materials and in addition should emphasize site-specific information.
- Radiological Worker I training, including High/Very High Radiation Area training (Article 632.4), should encompass at a minimum the following site-specific practical factors:
 - Entering and exiting simulated Radiological Buffer Areas and Radiation Areas (and High/Very High Radiation Areas when such training is included);
 - Performance of frisking for personnel contamination, as applicable;
 - Verification of instrument response and source check;
 - Anticipated response to alarm situations.

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Table 6-1, Training Requirements for Unescorted Entry

AREAS	RADIOLOGICAL WORKER I	RADIOLOGICAL WORKER II
Entry into Radiological Buffer Areas	YES	YES
Entry into Radiation Areas	YES	YES
Entry into High or Very High Radiation Areas*	NO**	YES
Entry into Contamination Areas and High Contamination Areas	NO	YES
Entry into Soil Contamination Areas (to perform work that disturbs soil)	NO	YES
Entry into Airborne Radioactivity Areas	NO	YES***

*Entry requirements further restricted by Article 334.

**Entry prohibited unless trained in accordance with Article 632.4.

***Requires respiratory protection qualification (Article 531).

4. Unescorted worker access to High or Very High Radiation Areas is permitted upon successful completion of Radiological Worker I training and High/Very High Radiation Area training. Completion of this training does not authorize access to Contamination, High Contamination, Soil Contamination, or Airborne Radioactivity Areas.

633 Radiological Worker II

Workers whose job assignments involve entry to High and Very High Radiation Areas, Contamination Areas, High Contamination Areas and Airborne Radioactivity Areas should complete Radiological Worker II training. Radiological Worker II training is not required for access limited to High or Very High Radiation Areas for workers trained in accordance with Article 632.4. Further, workers who have potential contact with hot particles or use of glove boxes with high contamination levels should complete Radiological Worker II training.

1. Radiological Worker II training should use the standardized core course training materials and in addition should emphasize site-specific information.
2. Radiological Worker II training should encompass at a minimum the following site-specific practical factors:
 - a. Donning of protective clothing;
 - b. Entering a simulated Radiological Buffer Area, Contamination Area and High Radiation Area to perform a task;
 - c. Anticipated response to simulated abnormal situations;
 - d. Anticipated response to simulated alarms or faulty radiological control equipment;
 - e. Removing protective clothing and equipment and subsequently exiting the simulated area;

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- f. Performance of frisking for personnel contamination;
- g. Verification of instrument response and source check.

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 II training and is required for personnel planning, preparing and performing jobs that have the potential for high 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.

635 Training Requirements for Escorted Individuals

1. *When an escort is used in lieu of training in accordance with Article 613.3 and 613.4, the escort shall [835.901(d)]:*
 - a. *Have completed radiation safety training, examinations, and performance demonstrations required for entry to the area and performance of the work; and [RPP # 207]*
 - b. *Ensure that all escorted individuals comply with the documented radiation protection program. [RPP # 208]*
2. Reserved.
3. When entry will be into a Radioactive Material Area, Radiological Buffer Area, Contamination Area, or Radiation Area, the escorted individual should be GERT trained, but no examination is required.

Note: All individuals entering a High Contamination Area, High or Very High Radiation Area, or Airborne Radioactivity Area should receive training in accordance with Article 613.4.

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PART 4 Health Physics Technician Qualification

641 Requirements

Training and qualification of Health Physics Technicians 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.

642 Health Physics Technician

1. ***Health Physics Technician qualification shall consist of the standardized core course training material, on-the-job training per the Qualification Standards, and passing both a final comprehensive written examination and final Oral Examination Board [835.901(a)]. [RPP # 199]***
2. Health Physics Technician training should use the standardized core course training materials and in addition should emphasize site-specific information.
3. Health Physics Technician 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.
4. Entry-level prerequisites should be established to ensure that Health Physics Technicians meet 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, other equipment and assist others in work locations, commensurate with assignment.
5. Health Physics Technicians are encouraged to pursue registration by the National Registry of Radiation Protection Technologists (NRRPT).
6. Sites are encouraged to give credit toward completion of standardized core training requirements for NRRPT registration.

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643 Continuing Training

1. Following successful completion of standardized core course requirements including practical training, the Health Physics Technician should pass a comprehensive written examination and should require a final Oral Examination Board or performance demonstration for final qualification.
2. Following initial Oral Examination Board qualification, the Health Physics Technician should begin a 2-year cycle of continuing training required for requalification. Every requalification requires completion of practical training and a comprehensive written examination. ***The contractor shall use examinations and performance demonstrations, appropriate to the level of training, for initial and requalification (not to exceed 24 months) of Radiological Worker I, Radiological Worker II, and Health Physics Technician training [HSD I.3].***
3. Continuing Training should provide continued improvement in the knowledge and skills of the Health Physics Technician.
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 written and oral examinations to prepare for the comprehensive biennial requalification.
6. Infrequently performed tasks, such as those for emergency response, may require annual training. Other tasks may require retraining prior to initiation of a task.
7. Personnel who maintain qualifications as a Health Physics Technicians satisfy the requirements of Radiological Worker II training.

644 Health Physics Technician Supervisors

1. Health Physics Technician supervisors should have qualified as Health Physics Technicians and should participate in continuing radiological training programs.
2. Health Physics Technician 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. Health Physics Technician supervisors should be re-qualified every two years through comprehensive written examination.
4. Oral Examination Boards should focus on the ability to analyze situations and supervise subordinates. The Health Physics Technician supervisor's depth of knowledge should exceed that expected of a Health Physics Technician.

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645 Subcontracted Health Physics Technicians

1. Subcontracted Health Physics Technicians should have the same knowledge and qualifications required of facility technicians performing the same duties. At a minimum, 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 recent operating experience;
 - f. Observation of on-the-job performances by the Health Physics 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. This should include successful completion of an oral examination in accordance with Article 642.

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PART 5 Other Radiological Training

651 Management Training

Line Managers (DOE and contractors) who manage, supervise or provide oversight of Radiological Control programs should be trained in the requirements of 10 CFR 835 and this Manual. Such training should be based on DOE standardized core course training materials supplemented by site-specific procedures and be completed by new personnel prior to formally assuming line supervision and management responsibilities. 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, and 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-1110-97, "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-1110-97, "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. Reserved.
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:

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- a. Applicable training on standardized core course topics from Radiological Worker I and II and Health Physics 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-1107-97, "Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities".
 5. Certification and involvement with professional industry organizations should be encouraged.

655 Radiographers and Radiation Generating Device Operators

Radiographers should have training commensurate with the level described in 10 CFR 34.43(g). Radiation Generating Device (RGD) Operators should have Radiological Worker training as described in Articles 632 and 633, as applicable and appropriate training on the type of equipment used and the radiation source involved. RGD Operators should have retraining every 24 months.

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.
3. Such training should be based on the Radiological Worker standardized 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.
7. *Each individual authorized to perform emergency actions likely to result in occupational doses exceeding the values of the limits provided in Table 2-1 shall [835.1302(d)] be trained in accordance with Article 613.4 and briefed beforehand on the known or anticipated hazards to which the individual will be subjected. [RPP # 254]*

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RADIOLOGICAL RECORDS
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PART 1 Requirements

711 Purpose

This chapter contains the prescribed practices for preparing and retaining radiologically related records. ***Radiological control records shall [835.701(a), 835.702(c)(1)] be maintained as necessary to document compliance with the requirements of 10 CFR 835 and with radiation protection programs required by §835.101. [RPP # 157, # 161]*** The work force and management are required to use records to document radiological safety afforded to personnel on-site. ***Records of radiological programs may be required to support worker health studies and future disputes or claims [HSD J.1]. Therefore, these records shall [HSD J.2] 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 contractor shall manage radiological records through an established records management program(s) consistent with processes and requirements established by the contractor. The program(s) shall address the potential legal and technical use of the completed records, including long term storage media requirements. This program(s) shall require records managements of the following: [HSD J.1]***

- ***Radiological Control Procedures [HSD J.1];***
- ***Individual radiological doses [HSD J.1];***
- ***Internal and external dosimetry policies and procedures (including bases documents) [HSD J.1];***
- ***Personnel training (course records and individual records) [HSD J.1];***
- ***Radiological instrumentation test, repair, and calibration [HSD J.1];***
- ***Radiological surveys [HSD J.1];***
- ***Area monitoring dosimetry results [835.703(b)][RPP # 181; HSD J.1];***
- ***Radiological Work Permits [HSD J.1];***
- ***Radiological incident and occurrence reports (and critique reports, if applicable) [HSD J.1];***
- ***Sealed radioactive source accountability and control [HSD J.1];***
- ***Release of material to uncontrolled areas [HSD J.1];***
- ***Reports of loss of radioactive material (required to be controlled and labeled in accordance with 10 CFR 835) [HSD J.1]; and***
- ***Minor consent forms (see section D) [HSD J.1].***

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The records management program should also include the following:

- ALARA records [also refer to Article 742];
- Radiological performance indicators and assessments; and
- Radiological policy statements.

2. *Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there shall [835.701(a)] 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. [RPP # 157]*

713 Recordkeeping Standards

1. The TOC shall ensure that permanent *radiological control records are accurate and legible, that all records are stored in a manner that ensures their integrity, retrievability and security [HSD J.2]. The contractor shall ensure that completed records contain sufficient detail to be understandable to those that may utilize the record in the future (i.e., intelligible to a person with training and experience equivalent to that of a person with a B.S. in health physics; for the life of the records) [HSD J.3].* 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 black or blue ink;
 - d. Corrections identified by a single line-out, initialed and dated;
 - e. Signature of supervisor or appointed designee to ensure review and proper completion of forms;
 - f. *Unless otherwise specified, the quantities used in the records required by this Manual shall [835.4] be clearly indicated in special units of curie, rad, roentgen, or rem, including multiples and subdivisions of these unit, or other conventional units, such as, dpm, dpm/100cm² or mass units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv), may be provided parenthetically for reference with scientific standards. [RPP # 21]*
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.
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.

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PART 2 Employee Records

721 Employment History

Records detailing an employee's pre-employment and employment history and the associated radiation dose should be maintained. 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:

1. Previous work history detailing radiological work assignments, to the extent practical, and yearly doses at other DOE and non-DOE facilities. *For radiological workers whose occupational dose is monitored in accordance with Articles 511 and 521, reasonable efforts shall [835.702(e)] be made to obtain complete records of prior years' occupational internal and external doses. [RPP # 176]*
2. Nuclear Regulatory Commission Form 4 or equivalent that documents previous occupational radiation doses. The TOC and DOE should use the Personnel Radiation Exposure History Form to document previous occupational radiation exposure.
3. Ongoing work history documenting work assignments and radiation doses; the facility and occupational codes defined in DOE 231.1-B should be used for this process.
4. When issued, DOE standardized forms to document previous and ongoing radiation doses.

722 Individual Monitoring Records

The Hanford site personnel radiological records, as defined in this section, should be maintained by the Radiation Records program.

1. *Except as described by Article 722.14, records shall [835.702(a); HSD J.4.a] be maintained to document doses received by all individuals for whom monitoring was conducted and to document doses received during planned special exposures, unplanned doses exceeding the monitoring thresholds of Articles 511 and 521, and authorized emergency exposures. The contractor shall ensure that the following records are maintained: [RPP # 159]*
 - a. *Records of personnel radiation exposure monitoring should be maintained in centralized records data storage. Hanford site personnel radiation exposure monitoring records are currently maintained by Hanford Radiological Records program.*

The results of individual external and internal dose monitoring that is performed, but not required by Articles 511 and 521, shall [835.702(b)] be recorded. [RPP # 160] Documentation of all occupational doses received during the current year, except for doses resulting from planned special exposures conducted in compliance with Article 213.3 and emergency exposures authorized in accordance with Article 213.4, shall [835.702(d)] be obtained to demonstrate compliance with dose limits in Table 2-1, for general employees. [RPP # 174] If complete records documenting previous occupational dose during the year cannot be obtained, a written estimate signed by the individual may be accepted to demonstrate compliance [835.702(d)]. [RPP # 175]

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2. *Individual monitoring records required by Article 722 shall [835.702(c)]:*
 - a. *Be sufficient to evaluate compliance with Articles 213, 214, and 215[RPP # 161]; and*
 - b. *Be sufficient to provide dose information necessary to complete reports required by Article 781. [RPP # 161, 162]*
3. *Routine and special records related to radiation doses shall [835.702(a-b)] be retained for each person monitored. Procedures, data, and supporting information necessary for future verification or reassessment of the recorded doses shall [835.702(g); 835.704(e)] be recorded. [RPP # 159, 160, & 178]*
4. *External dose records shall [835.702(c)(3)] include the following:*
 - a. *Results of monitoring used to determine individual occupational dose from external sources shall [835.703(b)] be documented and maintained [RPP #181]. Applicable extremity, skin, eye and whole body dose results measured with personnel dosimeters, including all multiple dosimeter badging results and area monitoring records;*
 - b. *Evaluations resulting from anomalous dose results such as unexpected high or low doses;*
 - c. *Dose reconstructions from lost or damaged dosimeters, or for unbadged workers;*
 - d. *Evaluations of nonuniform radiation doses;*
 - e. *Quantities for external dose received during the year; [RPP # 163]*
 - *The effective dose from external sources of radiation (equivalent dose to the whole body may be used as effective dose for external exposure); [RPP # 163]*
 - *The equivalent dose to the lens of the eye; [RPP # 164]*
 - *The equivalent dose to the skin; and [RPP # 165]*
 - *The equivalent dose to the extremities. [RPP # 166]*
5. *Internal dose records shall [835.702(c)(4)] include the following:*
 - a. *Results of monitoring used to determine individual occupational dose from internal sources shall [835.702(c)(4), 835.703(b)] be documented and maintained;*
 - b. *Applicable whole body and lung counting results (including chest wall thickness measurements where applicable);*
 - c. *Applicable urine and fecal specimen analysis results, including estimated intake and identity of radionuclides; [RPP # 167]*
 - d. *Dose assessment, as required [RPP # 181].*

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- e. Information for internal dose resulting from intakes received during the year [RPP # 181]:*
- *Committed effective dose; [RPP # 167]*
 - *Committed equivalent dose to any organ or tissue of concern; and [RPP # 168]*
 - *Identity of radionuclides. [RPP # 169]*
6. Reserved
7. *Include the following quantities for the summation of the external and internal dose [835.702(c)(5)]:*
- a. Total effective dose in a year; [RPP # 170]*
- b. For any organ or tissue assigned an internal dose during the year, the sum of the equivalent dose to the whole body from external exposures and the committed equivalent dose to that organ or tissue; and [RPP # 171]*
- c. Cumulative total effective dose. [RPP # 172]*
8. *The equivalent dose to the embryo/fetus of a declared pregnant worker shall [835.702(c)(6)] be maintained with the occupational exposure records for that worker. [RPP # 173]*
9. *Records of lifetime occupational dose, including cumulative total effective dose since January 1, 1989, shall [835.702(c)(2), 835.702(c)(5)] be maintained with the individual's occupational exposure records. [RPP # 162 & 172]*
10. Counseling of persons about radiological concerns should be documented and this documentation retained. It is desirable that the counseled person sign the documentation to acknowledge participation.
11. Records of authorization to exceed administrative control levels should be retained.
12. *Authorized emergency exposures and planned special exposures shall [835.204(a)(1), 835.204(f), 835.702(a), 835.702(c)(2), 835.1301(b)] be accounted for separately, but maintained with the individual's occupational exposure records. [RPP # 48, 159, 162, & 248]*
13. *Recording of the non-uniform equivalent dose to the skin is not required if the dose is less than 2 percent of the limit specified for the skin at Table 2-1 [835.702(b)]. [RPP # 160]*
14. *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 0.01 rem (0.1 mSv) committed effective dose. The bioassay or air monitoring result used to make the estimate shall be maintained in accordance with § 835.703(b) and the unrecorded internal dose estimated for any individual in a year shall not exceed the applicable monitoring threshold at § 835.402(c). [RPP # 160]*

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723 Other Personnel Radiological Records

1. ***The complete records of radiological incidents and occurrences involving personnel dose shall [835.702(a), 835.702(c)(2), 835.1301(b)] be retained. [RPP # 159,162, & 248]*** These include records of radiological incidents and occurrences resulting in changes to, or confirmation of, recorded exposures within personnel radiation exposure monitoring records. ***Records of radiological incidents and occurrences resulting in changes to, or confirmation of, recorded exposures within personnel radiation exposure monitoring records. The contractor shall ensure that, when practicable, these records are retained in or cross-referenced to applicable personnel radiation exposure monitoring records [HSD J.4.b].***
2. ***Records of employee radiological safety concerns that have been formally investigated and documented [HSD J.4.c].*** Records of these concerns should be maintained in the appropriate DOE or TOC Concern Program records.
3. ***Written declarations of pregnancy, including the estimated date of conception, and revocations of declarations of pregnancy shall [835.704(d)] be maintained. [RPP # 187]***
4. ***Changes in equipment, techniques, and procedures used for monitoring shall [835.704(e)] be documented. [RPP # 188]***

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 program should be documented.
4. Maintenance of records of non-occupational radiation doses, such as therapeutic or large amounts of diagnostic radiation doses for medical purposes, is encouraged. Where practical, maintenance of records of pre-employment, non-occupational radiation doses is encouraged.

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725 Radiological Training and Qualification Records

- 1. *Records of training and qualification in radiological control shall [835.704(a)] be maintained to demonstrate that a person received appropriate information to perform the work assignment in a safe manner. Qualification standard records shall [835.704(a)] be retained for on-the-job and practical factor training as well as for formal classroom training. [RPP # 184]***
- 2. First line supervision and management should review records of training and qualification to aid in making work assignments.**
- 3. *Personnel training records shall [835.704(a)] be controlled and retained. At a minimum, these records shall include the following:***
 - a. Course title***
 - b. Attendance sheets with instructor's name;***
 - c. Employee's name, identification number and signature;***
 - d. Date of training;***
 - e. Identification of the examination or evaluation form, including sufficient data to identify which test each person 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 acknowledgements of training, with the date and signature of the person trained; and***
 - i. Special instructions to individuals concerning prenatal radiation dose, acknowledged by the individual's signature. [RPP # 184]***
- 4. *Records shall [835.704(a)] be retained for the following types of radiation safety training:***
 - General employee radiological training;***
 - Radiological worker training;***
 - Periodic retraining;***
 - Training of radiological control technicians; and***
 - Members of the public training [RPP #184]***

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5. Records shall [835.704(a)] be retained for the following types of radiation safety training:

- ***Instructor training;***
- ***Training of other radiological control personnel;***
- ***Respiratory protection training;***
- ***Qualifications for special tests or operations;***
- ***Training of emergency response personnel;***
- ***Training of RGD operators; and***
- ***Onsite training of radiographers. [RPP # 184]***

6. The following instructional materials shall [835.704(a)] 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. 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. [RPP # 184]***

7. Documentation of training and qualification received at another DOE location need not be duplicated. [RPP # 184]

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PART 3 Member of the Public

731 Record Requirements

1. Documentation of completion of radiological training should be maintained for members of the public entering an area where radiation monitoring is required in accordance with Table 3-3.
2. *Records of doses, including zero dose, received by all members of the public for whom monitoring was performed shall [835.702(a), 835.702(c)(2)] be maintained. [RPP # 159 & 162] These records shall [835.702(c)(2)] be sufficient to evaluate compliance with all applicable dose limits and monitoring and reporting requirements. [RPP # 162]*

732 Reports

10 CFR 835.801(b) requires that a termination dose report be provided only upon request of the individual terminating employment. This requirement includes visiting scientists and transient workers, such as technicians and specialists who perform work at a facility and then leave to work elsewhere. ***The termination dose report shall [835.801(b)] be provided to the requesting individual as soon as data are available, but not later than 90 days after termination. [RPP # 193] A written estimate, based upon available information, shall [835.801(b)] be provided upon termination, if requested. [RPP # 194]*** The provisions for termination dose reports and written estimates only apply if the individual requests this information on or before the individual's last day of employment. If the request is made after the termination date, then the request should be handled in accordance with Article 781.3. When a termination dose report is provided to an individual, then an annual report to that individual, under Article 781.3, is not necessary.

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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 Records

Actions taken to maintain occupational exposures As Low As Reasonably Achievable, including actions required for this purpose in the Radiation Protection program (RPP), as well as facility design and control actions required by Articles 128 and 311, shall [835.704(b)] be documented. [RPP # 185]

These records should include the minutes of ALARA committees and other committees where radiological safety issues are formally discussed.

743 Quality Assurance Records

Records shall [835.704 (c)] be maintained to document the results of internal audits and other reviews of Radiation Protection program content and implementation [RPP # 186] to ensure that sufficient records are specified, prepared, reviewed, approved and maintained to accurately reflect completed work. DOE O 414.1D and 10 CFR 830.120 provide additional information regarding quality assurance records.

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PART 5 Radiological Surveys**751 Requirements**

1. ***Results of monitoring for radiation and radioactive material as required by Articles 421 and 423, and Chapter 5, Part 5, shall [835.703(a)] be documented and maintained. [RPP # 180]***
Radiological Control programs require the performance of radiation, airborne radioactivity and contamination surveys to determine existing conditions in a given location. Maps with sufficient detail to permit identification of original survey and sampling locations should be maintained. Records should contain sufficient detail to be meaningful even after the originator is no longer available. ***The contractor shall ensure that monitoring and workplace records include sufficient information to clearly identify the location or facility, purpose, results, individual, and contractor performing the monitoring [HSD J.5].***
2. ***Changes in equipment, techniques, and procedures used for monitoring shall [835.704(e)] be documented. [RPP # 188]***

752 Radiation Surveys

1. ***In addition to the elements provided in Article 751, records of radiation surveys shall [835.703(a)] include, at a minimum, the following information:***
 - a. ***Instrument model and serial number; and***
 - b. ***Results of the measurements of area dose rates. [RPP # 180]***

753 Airborne Radioactivity

1. ***In addition to the elements provided in Article 751, records of airborne radioactivity shall [835.703(a), 835.703(b)] include, at a minimum, the following information:***
 - a. ***Model and serial numbers of the sampler and laboratory counting instrument when available or unique identifier of each sampler and instrument;***
 - b. ***Location of fixed air samplers;***
 - c. ***Location of portable air samplers used for a survey [RPP # 180];***
 - d. ***Air concentrations in general airborne areas and breathing zones; and***
 - e. ***Supporting parameters, including collection efficiency, flow rate, duration of sampling, correction factors and filter medium. [RPP # 180, # 181]***

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754 Contamination and Release Surveys

- 1. *In addition to the elements required by Article 751, records of contamination surveys shall [835.703(a)] include, at a minimum, the following information:***
 - a. *Model and serial number of counting equipment;***
 - b. *Contamination levels (using appropriate units) and appropriate supporting parameters including counting efficiency, counting time, correction factors, type of radiation and whether the contamination was fixed or removable;***
 - c. *Location of areas found to contain hot particles or high concentrations of localized contamination; and***
 - d. *Follow-up survey results for decontamination processes cross-referenced to the original survey. [RPP # 180]***
- 2. Information should be documented and maintained regarding the results of monitoring for the release and control of material and equipment as required by Article 421.**

755 Sealed Radioactive Source Leak Tests and Inventories

- 1. *Records shall [835.704(f)] be maintained as necessary to demonstrate compliance with the requirements of Article 431 for sealed radioactive source control, inventory, and source leak tests. [RPP # 189]***
- 2. *In addition to the elements provided in Article 751, records of sealed radioactive source leak tests shall [835.704(f)] include, at a minimum, the following information:***
 - a. *Model and serial number of counting equipment;***
 - b. *Contamination levels (using appropriate units) and appropriate supporting parameters including counting efficiency, counting time, correction factors, and type of radiation; and***
 - c. *Corrective actions for leaking sources. [RPP # 189]***
- 3. *Records of sealed radioactive source inventories shall [835.704(f)] include, at a minimum, the following information:***
 - a. *The physical location of each accountable sealed radioactive source;***
 - b. *Verification of the presence and adequacy of associated postings and labels; and***
 - c. *Verification of the adequacy of storage locations, containers, and devices. [RPP # 189]***

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PART 6 Instrumentation and Calibration Records**761 Calibration and Operational Checks**

1. *The contractor shall ensure that calibration records for instruments and equipment used for monitoring individuals, material, and areas include frequencies, method, dates, personnel who performed the calibration and traceability of calibration sources to National Institute of Standards and Technology or other acceptable standards [HSD J.6]. [RPP # 183]*
2. *Calibration records shall [835.703(d)] 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;*
 - k. *Dosimetry processing instrumentation; and*
 - l. *Other devices used in radiation detection or measurement, as applicable. [RPP # 183; HSD J.4.d]*
3. *Documentation of instrument operational checks shall [835.703(d)] be maintained for a period not less than the calibration period of the instrument or equipment. [RPP # 183]*
4. *Maintenance histories, including the nature of any defects and corrective actions taken, and calibration results for each instrument or equipment shall [835.703(d)] be created and retained. [RPP # 183]*

762 Special Calibration Records

Records of additional tests and checks of instrumentation or equipment 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 [835.703(d)] be retained. [RPP # 183]

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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. For records that have long-term retention requirements and are stored on media subject to degradation or obsolescence, the records system should provide for conversion to a more stable medium.

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 shall [835.701(a)] be administered:*

1. *Verification that the resultant copy is legible;*
2. *Confirmation that printed sides are copied; and*
3. *Periodic quality audits of the final filmed copy. [RPP # 157]*

773 Computerization of Records

1. Records may be transferred to magnetic 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 magnetic storage media should include the following:
 - a. A master index of documents on the magnetic 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; and
 - h. Assurance that previously stored information is retrievable and useable after system modifications.

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3. Optical disks may be used to archive records if the optical disks satisfy the following:
 - a. A reliable system to prevent overwriting or erasure of records;
 - b. Software and user controls consistent with Article 773.2;
 - c. Manufacturer recommendations relating to software control, disk life expectancy, environmental storage conditions and maintenance incorporated into policies and procedures; and
 - d. Quality controls on the copying and imaging processes consistent with Article 772.

774 Retention

1. DOE G 1324.5B and 10 CFR 835 describe procedures for retaining records. ***Unless otherwise specified in 10 CFR 835, records shall [835.701(b)] be retained until final disposition is authorized by DOE. [RPP # 158] All individual monitoring records required by Articles 721, 722, and 731.2, shall [835.702(h)] be transferred to DOE upon cessation of activities that could cause exposure to individuals. [RPP # 179]***
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, consistent with DOE G 1324.5B, 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., 1.0-hour, or greater, fire resistance rating;
 - b. Exposure to water damage caused by a 100-year flood; and
 - c. Exposure to windstorm velocities of 100-year recurrence.

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PART 8 Radiological Reporting**781 Reports to Individuals**

1. *Radiation exposure data for individuals monitored in accordance with Articles 511 and 521 shall [835.801(a)] be reported as specified in this section. [RPP # 190] The information shall [835.801(a)] include the data required under Article 722. [RPP # 191] Each notification and report shall [835.801(a)] be in writing and include: the DOE site or facility name, the name of the individual, and the individual's social security number, employee number, or other unique identification number. [RPP # 192]*
2. *Upon the request from an individual terminating employment, records of exposure shall [835.801(b)] be provided to that individual as soon as the data are available, but not later than 90 days after termination. [RPP # 193] A written estimate, based upon available information, shall [835.801(b)] be provided upon termination, if requested. [RPP # 194]*
3. *Each DOE- or DOE-contractor-operated site of facility shall [835.801(c)], on an annual basis, provide a radiation dose report to each individual monitored during the year at that site or facility in accordance with Articles 511 and 521. [RPP # 195]*
4. *The records specified in Articles 721 and 722 that are identified with a specific individual shall [835.702(f)] be readily available to that individual. [RPP # 177] Detailed information concerning any individual's exposure shall [835.801(d)] be made available to the individual upon request of that individual, consistent with the provisions of the Privacy Act (5 U.S.C. 552a). [RPP # 196]*
5. *When a DOE contractor is required to report to the Department, pursuant to Department requirements for occurrence reporting and processing, any exposure of an individual to radiation and/or radioactive material, or planned special exposure in accordance with Article 213.3, the contractor shall [835.801(e)] also provide that individual with a report on his or her exposure data included therein. [RPP # 197] Such report shall [835.801(e)] be transmitted at a time not later than the transmittal to the Department. [RPP # 198]*

782 Annual Radiation Report

DOE O 231.1B 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

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 4A of HNF-5183. [835.2a][RPP # 13]

Activity Median Aerodynamic Diameter (AMAD): means a particle size in an aerosol where 50 percent of the activity in the aerosol is associated with particles of aerodynamic diameter greater than the AMAD. [835.2a][RPP # 13]

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.

activation: Process of producing a radioactive material by bombardment with neutrons, protons or other nuclear particles.

administrative control level: A numerical dose constraint established at a level below the regulatory limits 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. [835.2a][RPP # 13]

airborne radioactivity area: 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 10 CFR 835; or
- 2) An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week. [835.2a][RPP # 13]

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. [835.2a][RPP # 13]

Authorized limit: means a limit on the concentration of residual radioactive material on the surfaces or within the property that has been derived consistent with DOE directives including the as low as reasonably achievable (ALARA) process requirements, given the anticipated use of the property and has been authorized by DOE to permit the release of the property from DOE radiological control. [835.2a][RPP # 13]

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As Low As Reasonably Achievable (ALARA): 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 Manual, 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.

ALARA Committee: Multidisciplined forum that reviews and advises management on improving progress toward minimizing radiation exposure and radiological releases.

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. [835.2a][RPP # 13]*

becquerel (Bq): The International System (SI) unit for activity of radioactive material. One becquerel is that quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second.

bioassay: means 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. [835.2a][RPP # 13]

calibration: means to adjust and/or determine 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. [835.2a][RPP # 13]*

company-issued clothing: Clothing provided by the company, such as work coveralls and shoes. For radiological control purposes, company-issued clothing shall be considered the same as personal clothing.

containment device: Barrier such as a glovebag, glovebox or tent for inhibiting the release of radioactive material from a specific location.

contamination: The presence of residual or unwanted radioactive material resulting from a DOE activity in or on a material or property.

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 Table 2-2 of HNF-5183, but do not exceed 100 times those values. [835.2a][RPP # 13]

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contamination reduction corridor: A defined pathway through a hazardous waste site contamination reduction zone where decontamination occurs.

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 pre-set levels.

contractor senior site executive: The person 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. For the Hanford site, a controlled area by this definition is called a radiologically controlled area to more precisely identify the reason for which control is established. [835.2a][RPP # 13]*

conventionally true value of a quantity: The commonly accepted, best estimate of the true value of a quantity. The conventionally true value and the associated uncertainty will normally be determined by comparison with a national or transfer standard, using a reference instrument that has been calibrated against a national or transfer standard.

counseling: Advice, information exchange and guidance provided to employees on radiologically related topics, such as dose perspectives; potential health effects from radiation exposure; skin contamination; contaminated wounds; internally deposited radioactivity; pregnancy; and radiation exposure. This advice and guidance is 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 Article 215. This declaration may be revoked, in writing, at any time by the declared pregnant worker. [835.2a][RPP # 13]*

decontamination: Process of removing radioactive contamination and materials from personnel, equipment or areas.

deposition, new confirmed: A deposition of radioactive material in the body or any organ or tissue of an individual identified during the current reporting period, confirmed through bioassay results to be greater than the site-determined reportable level.

derived air concentration (DAC): *means, for the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the ALI divided by the volume of air breathed by an average*

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worker for a working year of 2000 hours (assuming a breathing volume of 2400m³). For radionuclides listed in Appendix C of 10 CFR 835, 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 10 CFR 835, 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. [835.2a][RPP # 13]

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. [835.2a][RPP # 13]

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). [835.2a][RPP # 13]

direct contamination reading (soil): the apparent surface contamination level, expressed in disintegrations per minute per a given area, resulting when an appropriate contamination probe or detector is placed in close proximity (~ ¼ inch) to the removed soil surface, e.g. soil, in question. 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.

DOE: means the United States Department of Energy. [835.2a][RPP # 13]

DOE activity: means an activity taken for or by the DOE 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, decontamination 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. [835.2a][RPP # 13]

DOELAP: Department of Energy Laboratory Accreditation Program for personnel dosimetry under DOE 5480.15.

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 Manual. It is the amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as equivalent dose, effective dose and collective dose, are used to evaluate the amount of radiation exposed workers receive. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation.

Some types of radiation, such as neutron and alpha, deposit their energy more densely in affected tissue than gamma radiation, thereby causing more damage to tissue. The term **equivalent dose**, measured in units of rem, is used to take into account this difference in tissue damage. Therefore 1 rem from gamma radiation causes damage **equivalent** to 1 rem from alpha radiation. However, it takes one-twentieth as

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much energy from alpha radiation, as compared with gamma radiation, to produce this 1 rem equivalent dose.

Dose terms: Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following: [835.2b][RPP # 13]

absorbed dose (D): means the average energy imparted by ionizing radiation to the matter in a volume per unit mass of irradiated material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

collective dose: the sum of the total effective dose values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

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 rem (or sievert) (1 rem = 0.01 sievert).

committed effective dose (E_{50}): means the sum of the committed equivalent doses to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate tissue weighting factor (w_T)--that is, $E_{50} = \sum w_T H_{T,50} + w_{\text{Remainder}} H_{\text{Remainder},50}$. Where $w_{\text{Remainder}}$ is the tissue weighting factor assigned to the remainder organs and tissues and $H_{\text{Remainder},50}$ is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rem (or sievert). ***[835.2b][RPP # 13]***

cumulative total effective dose: means the sum of all total effective dose values recorded for an individual plus, for occupational doses received before the implementation date of this revision, the cumulative total effective dose equivalent (as defined in the November 4, 1998 amendment to 10 CFR 835) values recorded for an individual, where available, for each year occupational dose was received, beginning January 1, 1989. [835.2b][RPP # 13]

dose assessment: process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.

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 rem (or sievert) (1 rem = 0.01 sievert).

effective dose (E): means the summation of the products of the equivalent dose received by specified tissues of the body (H_T) and the appropriate tissue weighting factor (w_T)--that is, $E = \sum w_T H_T$. It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with the HNF-5183 equivalent dose to the whole body may be used as effective dose for external exposures. The effective dose is expressed in units of rem (or sievert).

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external dose or exposure: means that portion of the equivalent dose received from radiation sources outside the body (i.e., “external sources”).

extremity: means hands and arms below the elbow or feet and legs below the knee.

internal dose or exposure: means that portion of the equivalent dose received from radioactive material taken into the body (i.e., “internal sources”).

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.

- a. The radiation weighting factors to be used for determining equivalent dose in rem are as follow:

Radiation Weighting Factors¹, 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 [835.2].

^{b3} 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:

$$W_R = 5 + 17 \exp(-(\ln(2E_n))^2/6) \text{ where } E_n \text{ is the neutron energy in MeV}$$

total effective dose (TED): means the sum of the effective dose (for external exposures) and the committed effective dose .

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. The tissue weighting factors are as follows:

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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 surface	0.01
Remainder ¹	0.05
Whole body ²	1.00

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 ($H_{\text{remainder}}$), 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.

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.

End of dose terms. [835.2b][RPP # 13]

embryo/fetus: Developing human organism from conception until birth. Same as unborn child.

engineering controls: Use of components and systems to reduce airborne radioactivity and the spread of contamination by using piping, containment, ventilation, filtration or shielding.

entrance or access point: means 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. [835.2a][RPP # 13]

extremity: Hands and arms below the elbow or feet and legs below the knee.

facility: For the purpose of this Manual, a facility includes systems, buildings, utilities, and related activities whose use is directed to a common purpose at a single location. Example 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

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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 material with induced radioactivity resulting from activation processes.

flash X-ray unit: Any device that is capable of generating pulsed X-rays.

frisk or frisking: Process of monitoring personnel for contamination. Frisking can be performed with hand-held survey instruments, automated monitoring devices or by a Health Physics Technician (HPT).

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[835.2a]. [RPP # 13]*

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 Chapter 2, Table 2-2, of this Manual. [835.2a][RPP # 13]*

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 rem (0.001 Sv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. [835.2a][RPP # 13]*

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. At the Hanford site, hot particles are defined as small (typically with dimensions of less than or about 1 mm), generally insoluble particles with an activity in excess of 10 .Ci.

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 mrem (1 mSv) per hour (equivalent dose rate to the whole body) on contact.

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immediately adjacent: As applied to Article 338.2, the term “immediately adjacent” must meet the following criteria: (1) The worker immediately exits the Contamination Area (CA) step-off pad through the adjoining Radiological Buffer Area (RBA) to an uncontrolled area, (2) RBA exit paths are being routinely monitored during heavy use to verify that contamination levels are maintained less than Table 2-2 limits, and (3) the term only applies in well-established and characterized doffing areas such as change trailers and survey tents. For the purposes of Article 338.2, this definition does not apply to corridors greater than 10 feet in length, or to remote work locations in outdoor RBA areas.

individual: *means any human being. [835.2a][RPP # 13]*

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 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 Manual, acceptable radiological controls for irradiator use are specified in Title 10, Code of Federal Regulations, Part 20.1603.

key radiation protection position: A person specifically designated within the radiological health and safety organization to exercise discretionary authority and/or make independent judgments and decisions beyond those covered by established procedures concerning radiation protection issues associated with the design, construction, operation and maintenance, or decommissioning of facilities and/or activities.

lifetime dose: Total occupational dose over a worker’s lifetime, including external and committed internal dose.

low-level waste: Waste that contains radioactivity 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. [835.2a][RPP # 13]*

minor: *means an individual less than 18 years of age. [835.2a][RPP # 13]*

mixed waste: Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively.

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. [835.2a][RPP # 13]*

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nonstochastic 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).

nuclear criticality: A self-sustaining chain reaction, i.e., the state in which the effective neutron multiplication constant of a system of fissionable material equals or exceeds unity.

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. [835.2a][RPP # 13]*

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. [835.2a][RPP # 13]*

personnel dosimeters: Devices designed to be worn by a single individual for the assessment of external 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 radioactive material present.

personal protective equipment: Equipment such as respirators, face shields and safety glasses used to protect workers from excessive exposure to radioactive or hazardous materials.

planned special exposure: Preplanned, infrequent exposure to radiation, separate from and in addition to the annual dose limits.

prefilter: Filter that provides first stage air filtration to remove larger particulates and prolong the efficient use of a HEPA filter.

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, personal and company issued clothing contamination. Also referred to as "anticontamination clothing," "anti-Cs" and "PCs."

public: Any individual or group of individuals who is not occupationally exposed to radiation or radioactive material. An individual is not a "member of the public" during any period in which the individual receives an occupational dose.

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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 Health Physics 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. [835.2a][RPP # 13]*

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 one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. [835.2a][RPP # 13]*

radiation generating device: A collective term for devices that produce ionizing radiation, including certain sealed sources that emit ionizing radiation, small particle accelerators used for single purpose applications which produce ionizing radiation (e.g., radiography), and electron-generating devices that produce x-rays incidentally. The term as used in this Manual does not apply to video display terminals or other consumer products that only produce radiation considered to be background. Sealed radioactive sources that are capable of generating external radiation fields of 100 mrem/hr or greater at 30 centimeters from the accessible surface will be classified as an RGD.

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, 10 CFR 835 establishes 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: *means 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 4A of HNF-5183[835.2a]. [RPP # 13]*

radioactive material transportation: *means the movement of radioactive material by aircraft, rail, vessel, or highway vehicle when such movement is subject to Department of Transportation regulations or DOE Orders that govern such movements. Radioactive material transportation does not include preparation of material or packaging for transportation, monitoring required by this Manual, storage of material awaiting transportation, or application of markings and labels required for transportation. [835.2a][RPP # 13]*

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.

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radioactivity: A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy 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 nondestructive methods, using a radioactive source or a radiation generating device.

radiological area: *means any area within a controlled area (but not including the controlled area) defined in the HNF-5183 as a “radiation area,” “high radiation area,” “very high radiation area,” “contamination area,” “high contamination area,” or “airborne radioactivity area.” [835.2a][RPP # 13]*

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 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:

- Work on contaminated or potentially contaminated facilities or systems
- Work in Radiological Buffer Areas (for contamination)
- Work in Radiation, High Radiation, and Very High Radiation Areas
- Work in Contamination, High Contamination, and Airborne Radioactivity Areas
- Work in contaminated or potentially contaminated soil (including digging, excavating, or disturbing the soil)
- Packaging or unpackaging of radioactive material
- Work in any area where there is a high probability of radioactive material being present
- Work requiring health physics (HP) hold points.

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 sievert) per year total effective dose. [835.2a][RPP # 13]*

radiologically controlled area (RCA): Any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material. (Defined as “controlled area” in 10 CFR 835)

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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. [835.2a][RPP # 13]

real-time air monitoring: means measurement of the concentrations or quantities of airborne radioactive materials on a continuous basis. [835.2a][RPP # 13]

refresher training: Training scheduled on the alternate year when full retraining 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 guidelines in DOE 458.1.

rem: Unit of either equivalent or effective dose. Equivalent dose in rem is numerically equal to the absorbed dose in rad multiplied by a radiation weighting factor. Effective dose in rem is numerically equal to the absorbed dose in rad multiplied by a radiation weighting factor, tissue weighting factor and any other necessary modifying factor (1 rem = 0.01 sievert).

removable contamination: Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or washing.

representative sample: A sample that closely approximates both the concentration of activity and the physical and chemical properties of material (e.g., particle size and solubility in case of air sampling of the aerosol to which workers may be exposed).

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. [835.2a][RPP # 13]

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. [835.2a][RPP # 13]

sievert (Sv): SI unit of any of the quantities expressed as equivalent dose or effective dose. The equivalent dose in sieverts is numerically equal to the absorbed dose in grays multiplied by the radiation weighting factor. Effective dose in sieverts is numerically equal to the absorbed dose in grays multiplied by a radiation weighting factor, tissue weighting factor and any other necessary modifying 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: The upper layer of earth that can be tilled and in which vegetation may grow, and including organic material such as vegetation or animal wastes that are deposited or mixed into the soil, and rubblized construction or deactivation and decommissioning debris.

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soil contamination area (SCA): *An area in which radioactive material exists within the top 15 centimeters of soil such that [835.1102(b)]:*

1. *A direct contamination reading of the soil surface exceeds the appropriate “total” contamination levels in Appendix D, 10 CFR 835, and*
2. *The transferable contamination from the area does not exceed the appropriate “removable” levels in Appendix D, 10 CFR 835. [RPP # 230]*

soil intrusive activity: Any human activity that disturbs the surface and/or subsurface of the soil which has a reasonable possibility of increasing the amount of transferable contamination within a soil contamination area or an underground radioactive material area.

source leak test: means a test to determine if a sealed radioactive source is leaking radioactive material. [835.2a] [RPP # 13]

Special tritium compound: *means any compound, except H₂O, that contains tritium, either intentionally (e.g., by synthesis) or inadvertently (e.g., by contamination mechanisms). [835.2a] [RPP # 13]*

standard radiation symbols: Symbols designed and proportioned as illustrated in accordance with ANSI N2.1 for radiation symbols and ANSI N12.1 for fissile material.

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. [835.2a] [RPP # 13]*

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 equivalency determination (TED): a TED (called an Article 113 determination in the DOE Radiological Control Manual) is a documented alternative solution, with supporting technical basis, analysis, and justification to demonstrate technical equivalency in lieu of a “should” provision of the DOE Radiological Control Manual. See Article 113.3 for additional criteria.

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.

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thermoluminescent dosimeter (TLD): Radiation monitoring device used to record the radiological exposure of personnel or areas to certain types of radiation.

transferable contamination: The total contamination levels, expressed in terms of disintegrations per minute per a given area, on items such as shoes, shoe covers, vehicle tires, tools, or other equipment which has 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.

underground radioactive material area (URMA): An area that contains radioactive materials above DOE Order 458.1 Section 4.k (CRD Section 2.k) release/clearance levels below the top 15 cm of soil, or below any layer of impervious soil cover material, e.g., asphalt, concrete. Radioactive materials may include pipelines, radioactive cribs, covered ponds, covered ditches, catch tanks, inactive burial grounds, and sites of known, covered, unplanned releases (spills).

unusual occurrence: Nonemergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations. Examples of the types of occurrences that are to be categorized as unusual occurrences are contained in DOE 5000.3A.

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. [835.2a] [RPP # 13]*

visitor: Person requesting access to Controlled Areas who has not been trained to the level required to permit unescorted access.

week: *means a period of seven consecutive days [835.2a]. [RPP # 13]*

whole body dose: The sum of the annual equivalent dose to the whole body for external exposures and the committed effective dose for internal exposures.

worker (Hanford): A “general employee” as defined in 10 CFR 835 who is either a DOE or DOE contractor employee assigned to the Hanford site; employee of a subcontractor to a Hanford DOE contractor; or an individual who performs work for or in conjunction with DOE or utilizes DOE facilities on the Hanford site.

worker (non-Hanford): A “general employee” as defined in 10 CFR 835 who is not a Hanford worker.

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 Manual. 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 [835.2a]. [RPP # 13]*

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: Tank Farm Radiologic Control Manual	Information Category: <input type="checkbox"/> Abstract <input type="checkbox"/> Journal Article <input type="checkbox"/> Summary <input type="checkbox"/> Internet <input type="checkbox"/> Visual Aid <input type="checkbox"/> Software <input type="checkbox"/> Full Paper <input checked="" type="checkbox"/> Report <input type="checkbox"/> Other _____
Publish to OSTI? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Trademark/Copyright "Right to Use" Information or Permission Documentation <input type="checkbox"/> Yes <input checked="" type="checkbox"/> NA
Document Number: HNF-5183 Revision 50	Date: April 2019
Author: Darling, David / Chadly, Peter B	

Part II: External/Public Presentation Information

Conference Name: _____	
Sponsoring Organization(s): David Darling	
Date of Conference: _____	Conference Location: _____
Will Material be Handed Out? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Will Information be Published? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <i>(If Yes, attach copy of Conference format instructions/guidance.)</i>

Part III: WRPS Document Originator Checklist

Description	Yes	N/A	Print/Sign/Date
Information Product meets requirements in TFC-BSM-AD-C-01?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
If product contains pictures, safety review completed?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

Part IV: WRPS Internal Review

Function	Organization	Date	Print Name/Signature/Date
Subject Matter Expert	WRPS	09/18/2020	Chadly, Peter B Approved - IDMS data file att.
Responsible Manager	WRPS	09/02/2020	Kurtz, Jerry E Approved - IDMS data file att.
Other:			

Part V: IRM Clearance Services Review

Description	Yes	No	Print Name/Signature
Document Contains Classified Information?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	If Answer is "Yes," ADC Approval Required _____ Print Name/Signature/Date
Document Contains Information Restricted by DOE Operational Security Guidelines?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Reviewer Signature: _____ Print Name/Signature/Date
Document is Subject to Release Restrictions? <i>If the answer is "Yes," please mark category at right and describe limitation or responsible organization below:</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Document contains: <input type="checkbox"/> Applied Technology <input type="checkbox"/> Protected CRADA <input type="checkbox"/> Personal/Private <input type="checkbox"/> Export Controlled <input type="checkbox"/> Proprietary <input type="checkbox"/> Procurement – Sensitive <input type="checkbox"/> Patentable Info. <input type="checkbox"/> OUO <input type="checkbox"/> Predecisional Info. <input type="checkbox"/> UCNI <input type="checkbox"/> Restricted by Operational Security Guidelines <input type="checkbox"/> Other (Specify) _____
Additional Comments from Information Clearance Specialist Review?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Information Clearance Specialist Approval <div style="border: 1px solid green; padding: 5px; display: inline-block; color: green; font-weight: bold;"> APPROVED </div> <i>By Sarah Harrison at 11:34 am, Oct 06, 2020</i> _____ Print Name/Signature/Date

When IRM Clearance Review is Complete – Return to WRPS Originator for Final Signature Routing (Part VI)

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part VI: Final Review and Approvals

Description	Approved for Release		Print Name/Signature	
	Yes	N/A		
WRPS External Affairs	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Mc Cune, Hal C	Approved - IDMS data file att.
WRPS Office of Chief Counsel	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Peters, Amber D	Approved - IDMS data file att.
DOE – ORP Public Affairs/Communications	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Tyree, Geoffrey T	Approved - IDMS data file att.
Other: ORP OCC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	King, Grace J	Approved - IDMS data file att.
Other: ORP SME	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Williamson, Brandon I	Approved - IDMS data file att.

Comments Required for WRPS-Indicate Purpose of Document:

To support NRC review of the Draft Vitrified Low-Activity Waste Incidental to Reprocessing Evaluation.

APPROVED
By Sarah Harrison at 11:35 am, Oct 06, 2020

**Approved for Public Release;
Further Dissemination Unlimited**

Information Release Station

Was/Is Information Product Approved for Release? Yes No

If Yes, what is the Level of Releaser? Public/Unrestricted Other (Specify) _____

Date Information Product Stamped/Marked for Release: 10/06/2020

Was/Is Information Product Transferred to OSTI? Yes No

Forward Copies of Completed Form to WRPS Originator

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    Darling for public external release. Thank you, Sarah Harrison Information
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