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U.S. Department of Energy

Radiological Control Manual

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DEPARTMENT OF ENERGY

Radiological Health and Safety Policy

It is the policy of DOE to conduct its radiological operations in a manner that ensures the health and safety of all its employees, contractors, and the general public. In achieving this objective, DOE shall ensure that radiation exposures to its workers and the public and releases of radioactivity to the environment are maintained below regulatory limits and deliberate efforts are taken to further reduce exposures and releases in accordance with a process that seeks to make any such exposures or releases as low as reasonably achievable. The DOE is fully committed to implementing a radiological control program of the highest quality that consistently reflects this policy.

In meeting this policy, DOE shall:

1. **Establish and maintain a system of regulatory policy and guidance reflective of national and international radiation protection standards and recommendations.** The Assistant Secretary for Environment, Safety and Health (or the Director, Naval Reactors, for that program) has responsibility for promulgating and maintaining policies, standards, and guidance related to radiological protection. Departmental radiological protection requirements are, at a minimum, consistent with the Presidentially approved Radiation Protection Guidance to Federal Agencies developed by the Environmental Protection Agency in accordance with its mandated Federal guidance responsibilities. Departmental requirements often are more stringent and reflect, as appropriate, recommendations and guidance from various national and international standards-setting and scientific organizations, including the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, the American National Standards Institute, and others. The DOE requirements related to radiological protection will be set forth, as appropriate, in rules and DOE Orders, and guidance documents will be issued on acceptable means to implement these requirements.

2. **Ensure personnel responsible for performing radiological work activities are appropriately trained.** Standards shall be established to ensure the technical competency of the DOE work force, as appropriate, through implementation of standardized and mandated radiological training and development programs.

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

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

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

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

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

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

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

DOE RADIOLOGICAL HEALTH AND SAFETY POLICY

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PART 1 Department of Energy (DOE) Radiological Control Manual

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 Department of Energy 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 throughout the Department.

DEPARTMENT OF ENERGY RADIOLOGICAL CONTROL POLICY

ALARA

Personal radiation exposure shall be maintained As-Low-As-Reasonably-Achievable (ALARA).

Radiation exposure of the work force and public shall be controlled such that radiation exposures are well below regulatory limits and that there is no radiation exposure without commensurate benefit.

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 establishes practices for the conduct of Department of Energy radiological control activities. The Manual states DOE's positions and views on the best courses of action currently available in the area of radiological controls. Accordingly, the provisions in the Manual should be viewed by contractors as an acceptable technique, method or solution for fulfilling their duties and responsibilities. This Manual shall be used by DOE in evaluating the performance of its contractors.

The Manual is not a substitute for Regulations; it is intended to be consistent with all relevant statutory and regulatory requirements and shall be revised whenever necessary to ensure such consistency. 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.

1. The provisions of this Manual apply to DOE or DOE-funded activities performed at DOE sites or facilities, where radiation or radioactive material is present or being used.

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, and such organizations do not possess one of the following:
   a. A U.S. Nuclear Regulatory Commission (NRC) license
   b. An Agreement State license
   c. An appropriate state license, registration, or certification with a documented radiation protection program, plan, and procedures which provide a level of protection equivalent to that required by DOE, NRC or other appropriate Federal standards.

   The lead Secretarial Officer and the Office of Environment, Safety and Health shall be included in the review and concurrence process in these situations. In those cases at non-DOE sites or facilities where a specific radiological activity is being conducted pursuant to an NRC or Agreement State license, or appropriate state license, registration, or certification, the provisions of this Manual are not binding to that activity.

3. The provisions of this Manual are not binding upon activities at DOE sites that are mandated by legislation to be performed pursuant to an NRC license including activities certified by the NRC under section 1701 of the Atomic Energy Act.

4. This Manual is a living document. DOE intends to review and update provisions on a periodic basis to incorporate lessons learned and suggestions for improvement. The Assistant Secretary for Environment, Safety and Health is responsible for this task. Recommendations to correct or improve this Manual are encouraged and should be sent to the Radiological Control Program Advisor (Article 151[1]) of the Secretarial Officer responsible for the affected work activity. Information copies should also be sent to the other members of the Radiological Control Coordinating Committee (Article 153). The Secretarial Officer will transmit such recommendations to the Office of Environment, Safety and Health for consideration. The recommended wording of the change, as well as the basis and justification for the change, should be included.

5. The Department of Energy intends to incorporate by reference the provisions in this Manual into contracts or regulatory plans, as appropriate. These incorporated provisions shall be enforceable pursuant to the contract or underlying regulations. No exception to or interpretation of an incorporated provision shall be provided pursuant to the contract. When incorporating a provision, DOE shall approve an implementation plan that includes a compliance schedule. It is expected that implementation of this Manual will occur in a phased manner over a period of time consistent with the schedules and resources identified in the DOE-approved implementation plan.

6. This Manual shall be kept current and should be entered into the contractor document control system. The Office of Environment, Safety and Health shall ensure that a current version of this Manual is maintained on the DOE Safety Performance Measurement System (SPMS).

7. The provisions of this Manual do not apply to facilities and activities of the Naval Nuclear Propulsion Program, which are separately covered under Executive Order 12344 (42 U.S.C 7158, note) and patients undergoing medical treatment at a DOE or DOE-funded facility.

[1] The term "Article" is used to reference portions or sections of this document. For ease of communications, portions of this document should be referred to as Articles. For example, the appropriate reference to the Article containing this footnote is Article 112.3.

113 Compliance

1. This Manual sets forth DOE's views 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. When incorporated into contracts, the provisions of the Manual are binding requirements. The words "shall" and "should" have the meaning below when a provision is incorporated into a contract.

2. The word "shall" identifies those elements and requirements that have been considered and found by DOE to be mandatory unless prior approval of an alternative approach is obtained from DOE Headquarters. If a contractor wishes to implement an alternative approach, the contractor shall submit the suggested alternative approach to the lead Secretarial Officer for review. Prior to final approval by the lead Secretarial Officer, other affected Secretarial Officers and the Office of Environment, Safety and Health shall concur on the suggested alternative approach. The submittal shall contain the description of the alternative approach, the technical rationale and basis, the suggested wording and justification that the alternative will achieve equal or improved performance employing equal or better techniques, solutions or methods.

3. The word "should" means the contractor 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 a contractor decides to follow an alternative technique, approach or method in lieu of the "should" provision, the following actions are required:

   - The alternative solution shall be documented, with supporting technical basis, analysis and justification to demonstrate technical equivalency.

   - Prior to implementation, the approval of the Radiological Control Manager and the contractor's senior line manager responsible for operations shall be required. DOE approval is not required nor expected.

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

- At the conclusion of each calendar year each contractor shall provide to the DOE Operations Office Manager and the lead Secretarial Officer a tabulation of all such equivalency determinations approved within the past 12 months. For ease of reference, these may be referred to as Article 113 determinations.

114 Site-Specific Manual

1. A Site-Specific Radiological Control Manual that invokes the requirements of this Manual shall be issued and endorsed by the contractor senior site executive. The Site-Specific Radiological Control Manual does not require review or approval by the DOE. One approach in the development of Site-Specific Radiological Control Manuals is to invoke the provisions of this Manual as written with site specific additions, supplements and clarifications clearly indicated, included in the appropriate chapters and directly referenced to the corresponding Article. Additions and supplements to address unique situations or to provide more detailed or prescriptive direction may be included only if these additions do not conflict with or diminish the requirements of this Manual. The contractor senior site executive is that 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.

2. Management policies, requirements, expectations and objectives for the site Radiological Control Program should be clearly and unambiguously stated.

3. The Site-Specific Manual shall be kept current and entered into the contractor document control system.

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

5. Subcontractors shall comply with the Site-Specific Radiological Control Manual.

6. Where DOE employees are conducting the transport of nuclear devices or components, a Program Specific Radiological Control Manual, based upon the provisions of this Manual, shall be issued and approved by the DOE Operations Office Manager. Controlled copies of such Manuals shall be provided to the lead Secretarial Officer.

115 Application of Requirements

1. This Manual assumes that most facilities or sites have organizations in place that generally meet the requirements presented in the text. It is not the intent of this Manual to unnecessarily create new or separate organizations if those functions can be incorporated into existing ones. For example, the Radiological Awareness Committee functions of Article 132.3 may be performed by an existing safety committee. It is expected, however, that the existing committee charter be revised to reflect the requirements and emphasis of this Manual. Similarly, titles such as Radiological Control Manager and Radiological Control Technician that are used in the Manual may locally be designated differently. A phased approach to transition to the use of the titles of positions in this Manual should be adopted. Corresponding position descriptions and organizational charts should be revised to accurately reflect required radiological responsibilities.

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

116 User Groups

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

   Suggested User Group categories are as follows:

   - Reactors
   - Uranium
   - Environmental Restoration/Waste Management
   - Plutonium
   - Tritium
   - Accelerators
   - Large Research and Development Laboratory Operations
   - Small Research and Development Laboratory Operations (annual collective effective dose equivalent of one person-rem or less)

   The development of such Handbooks should be coordinated with the Office of Environment, Safety and Health.

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 work space. The DOE Operations Office Manager and the contractor senior site executive responsible for the site should have a basic knowledge of radiation, its effects and radiological control requirements. The DOE Operations Office Manager and the contractor senior site executive should also be familiar with the current radiological performance record. Key principles common in a successful, well-managed Radiological Control Program are provided in this Chapter.

121 Senior Management Commitment

1. Senior managers should establish high standards for 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 radioactive 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 shall 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 shall review progress toward the goals at least quarterly.

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

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.

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

2. 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.

3. 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.

4. 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 Radiological Control 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 below should be produced and displayed at appropriate access points and work areas.

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

<u>OBEY</u>

- 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.

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 5480.19, "Conduct of Operations Requirements for DOE Facilities." The concepts of all chapters of DOE 5480.19 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.

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, should have comparable training and shall meet the same requirements and expectations.

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

126 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 Radiological Control 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. This process complements the Occurrence Reporting and Processing System (ORPS) of DOE 5000.3B. The process should be used to quickly establish facts in chronological order so that the underlying reasons or causes for the success or failure are well understood. Work force participation should be encouraged. Critiques are a management tool and should not be used to "fix blame" or "shoot the messenger."

128 Facility Modifications and Radiological Design Considerations

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 major modifications to existing facilities are contained in 10 CFR 835 and DOE Order 6430.1A. In addition, the following radiological control design criteria are provided for new facilities and major modifications to existing facilities:

   a. Individual worker dose shall be ALARA and should be less than 500 mrem per year
   b. Discharges of radioactive liquid to the environment are covered by the provisions of DOE 5400.5 and should not degrade the groundwater
   c. Control of contamination should be achieved by containment of radioactive material
   d. Efficiency of maintenance, decontamination, operations, and decommissioning shall be maximized
   e. Components should be selected to minimize the buildup of radioactivity
   f. Support facilities shall be provided for donning and removal of protective clothing and for personnel monitoring, when required
   g. 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.

3. Existing facility designs that have office space and lunchrooms or eating areas within Radiation Areas, High and Very High Radiation Areas, Contamination and High Contamination Areas, Airborne Radioactivity Areas, Radioactive Material Areas and Radiological Buffer Areas require priority attention. Generally:

   a. Locating lunch rooms or eating areas, restrooms, drinking fountains, showers and similar facilities and devices is strongly discouraged within these areas
   b. Locating office spaces within these areas is strongly discouraged; to the extent that such space is essential to support radiological work, steps should be taken to preclude unnecessary occupancy.

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 contaminations 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.

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

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

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

132 Management of Radiological Performance Goals

1. The contractor senior site executive shall 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. Goals need to be developed primarily by those responsible for performing the work. Forming a Radiological Awareness Committee that includes the active participation of the work force is encouraged.

4. Radiological performance goals should be reviewed at least annually and revised as appropriate. Normally, more stringent goals should be set annually to reflect the improved radiological performance at the facility. Occasionally, a goal may be made less stringent to accommodate changes in work load or mission.

133 Radiological Performance Reports

1. The Radiological Control Manager should provide a periodic summary report to the contractor senior site executive for sites which exceed an annual collective dose of one person-rem. 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.

2. The Radiological Control Manager should provide radiation exposure information, such as supplemental dosimeter readings or volume of waste generated, 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.

3. To promote worker awareness of their radiation exposure status, selected indicators related to their work group should be posted in the workplace.

Table 1-1 Suggested Radiological Performance Indicators

Exposure control a. Collective dose in person-rem b. Average worker dose in rem c. Maximum dose to a worker in rem d. Number of unplanned exposures resulting in doses greater than the Administrative Control Level e. Number of dose assessments for lost or damaged dosimeters f. Maximum neutron dose to a worker in rem
Personnel contamination a. Number of skin and personal clothing contaminations b. Number of contaminated wounds c. Number of facial contaminations
Control of internal exposure a. Number of new confirmed depositions b. Number of airborne events c. Number of alarms on airborne monitors (actual and false) d. Number of Airborne Radioactivity Areas e. Area of Airborne Radioactivity Areas in square feet
Control of contaminated areas in operational areas a. Number of Contamination and High Contamination Areas b. Area of Contamination Areas in square feet c. Area of High Contamination Areas in square feet d. Number of spills
Minimization of radioactive waste a. Volume and activity of radioactive waste in cubic feet and curies, respectively b. Number of cubic feet not subject to volume reduction by incineration, compaction or other means
Control of radioactive discharges a. Activity of liquid radioactivity discharges in curies b. Activity of airborne radioactivity discharges in curies

134 Assessments

Assessment, as used in this 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 Radiological Control Program shall be conducted such that over a 3-year period, all functional elements are assessed for program performance, applicability, content and implementation. These should be performed by the Radiological Control Organization, the Quality Assurance Organization and other organizations.

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 do 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.

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 work force awareness, the program should encourage continuous evaluation and improvements, track resolution of concerns, provide feedback to employees, and post results and trends. This system may be integrated with similar reporting systems for other than 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 reduced to the minimum practicable level 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.

- Sampling of body excretions and whole-body or organ counting techniques encourage worker perceptions of internal exposure significance.

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 dose equivalent is more difficult to assess than gamma dose equivalent.

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

An ALARA Committee should be established. The membership should include managers and workers from the line, the technical support organization and the Radiological Control Organization. It is more effective if a line manager, such as Director of Operations, Research, or Maintenance serves as the Chair. This Committee may be part of a general safety or radiation safety committee whose functions include ALARA activities and possibly be combined with the Radiological Awareness Committee (see Article 132) for smaller facilities.

The ALARA Committee should make recommendations to management to improve progress toward minimizing radiation exposure and radiological releases. The Committee should evaluate items such as construction and design of facilities and systems, planned major modifications or work activities, as well as experimental test plans for exposure, waste and release minimization. The Committee should also receive, as a minimum, the results of all reviews and audits, both internal and external, and should review the overall conduct of the Radiological Control Program.

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.

PART 4 Contractor Radiological Control Organization

141 Radiological Control Organization

1. A Radiological Control Organization should be established to provide relevant support to line managers and workers. To 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 shall monitor adherence to the Site-Specific Radiological Control 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.

3. The Radiological Control Manager heads the Radiological Control Organization and is responsible for and should establish a high quality Radiological Control Program.

4. The Radiological Control Manager shall have access to the senior site executive for radiological control matters.

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

3. The Radiological Control Manager should have a minimum of a bachelor's degree or the equivalent in science or engineering, including some formal training in radiological control. Advanced academic degrees can count as experience where course work related to radiological control is involved. At least three years of professional experience should be in applied radiological control work. Certification by the American Board of Health Physics provides equivalency to the above.

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.

5. Management should provide persons assigned to or being considered for the Radiological Control Manager a structured program leading to certification by the American Board of Health Physics.

143 Radiological Control Organization Functions and Staffing

1. The senior staff of the Radiological Control Organization should include health physicists and other professionals with four-year degrees in science or engineering. A continuing training program shall be established. 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 should have technical qualifications pertinent to their assigned duties.

144 Relationship Between Radiological Control Technicians and Workers

Radiological Control 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 Radiological Control Technicians and their supervisors.

2. Radiological Control Technicians and their supervisors shall 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 the violation of radiological control standards or 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 work space
   b. Curtailment of work schedules
   c. Deferral of work
   d. Addition of extra radiological control personnel
   e. Conduct of additional training.

3. When the workers and supervisors achieve the proper level of radiological performance, the number of radiological control personnel should be reevaluated.

PART 5 DOE Management

151 Program Office

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

2. Each Secretarial Officer shall designate a person who can be the Program Office focal point on radiological control matters with the DOE Operations Office and applicable Field Office Managers, counterparts within DOE and the contractor organizations. This person is referred to in this Manual as the Radiological Control Program Advisor.

152 Operations Offices and Applicable Field Offices

1. Managers of Operations Offices and the Rocky Flats and Fernald Field Offices are responsible for the line management function of conducting day-to-day oversight of contractor activities, including monitoring the quality and performance of radiological work.

2. Managers of Operations Offices and the Rocky Flats and Fernald Field Offices shall designate a person to be responsible for providing radiological control program oversight, which includes appraisals, surveillance and monitoring of performance, interacting routinely with the Radiological Control Program Advisors of the affected DOE Program Offices, assisting the DOE field line organization in the use of this Manual and interacting on a periodic basis with counterparts at other sites.

153 Department Policy

The Assistant Secretary for Environment, Safety and Health (EH) is responsible for promulgating and maintaining the overall DOE policy and standards with respect to radiological health and safety. EH is also responsible for periodically revising the Manual to make corrections or improvements to the document. Subject matter experts within EH for areas such as radiological health effects, health physics, dosimetry, instrumentation, training and radiological controls should be relied upon by other DOE elements for technical support in addressing problems or unique situations.

154 Department Independent Radiological Control Performance Oversight

The Office of Environment, Safety and Health carries out its responsibility to provide independent radiological control performance oversight, on behalf of the Secretary of Energy, through various means, including the following:

1. Uses the Radiological Control Manual as its basis document.

2. Assesses DOE Program, Operations, and applicable Field Office performance of their line management responsibilities for implementing and maintaining radiological controls as detailed in the Radiological Control Manual.

3. Assesses contractor performance against the requirements of their Site-Specific Radiological Control Manual.

155 Radiological Control Coordinating Committee

1. The DOE Headquarters Radiological Control Coordinating Committee shall as a minimum, consist of the Radiological Control Program Advisors from the Offices of Defense Programs, Energy Research, Environmental Restoration and Waste Management and Nuclear Energy along with representatives from the Offices of Environment, Safety and Health and Field Management. A charter for this committee shall be approved and its performance monitored by the Deputy Secretary. A Chairperson shall be designated by the Deputy Secretary and should be appointed for a minimum of one year.

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

3. The Radiological Control Coordinating Committee should meet at least quarterly and more frequently during periods of transition.

4. Radiological Control Coordinating Committee meetings should include representatives from Operations Offices and recognized industry experts from outside the Department. The interaction with non-DOE professionals enhances the awareness of state-of-the-art technology and practices.

156 DOE Employees in the Workplace

DOE employees at a DOE site or facility are subject to and shall adhere to the provisions of this Manual and the contractor's Site-Specific Radiological Control Manual.

CHAPTER 2 RADIOLOGICAL STANDARDS

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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.

With issuance of this Manual, the committed effective dose equivalent is used to assign internal dose received by personnel at DOE facilities. The committed effective dose equivalent 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 Level

1. A DOE Administrative Control Level of 2,000 mrem per year per person is established for all DOE activities. Approval by the appropriate Secretarial Officer or designee shall be required prior to allowing a person to exceed 2,000 mrem.

2. An annual facility Administrative Control Level shall be established by the contractor senior site executive based upon an evaluation of historical and projected radiation exposures, work load and mission. The selection of the specific value shall be more restrictive than the DOE Administrative Control Level. This control level should be reevaluated annually. The choice of a low level for one year should not preclude choosing either a higher or lower level in a subsequent year.

3. For most facilities, an annual facility Administrative Control Level of 500 mrem or less should be challenging and achievable. An annual Administrative Control Level above 1,500 mrem is in most cases not sufficiently challenging to meet the goals of this Manual.

4. No person shall be allowed to go above the facility Administrative Control Level without the prior approval of the contractor senior site executive.

212 Lifetime Control Level

1. To administratively control a worker's lifetime occupational dose, a Lifetime Control Level of N rem shall be established where N is the age of the person in years. Special Control Levels (Article 216) shall be established for personnel who have doses exceeding N rem.

2. The internal contribution to lifetime occupational dose from intakes prior to January 1, 1989, should be calculated in terms of either cumulative annual effective dose equivalent or committed effective dose equivalent. 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.

213 Radiological Worker Dose Limits

1. Dose limits are provided in Table 2-1 and shall not be exceeded. All occupational exposure received during the current year shall be included when demonstrating compliance with Table 2-1 dose limits. These regulatory limits are consistent with the "Radiation Protection Guidance to Federal Agencies for Occupational Exposure" signed by the President.

2. Radiological workers from other DOE or DOE contractor facilities may receive occupational exposure as a radiological worker if they:

   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.

3. Proposed use of the Planned Special Exposure as specified in 10 CFR 835 shall be applied only in extraordinary situations and when the following requirements have been met:

   a. The proposed activity has been reviewed by the Radiological Control Manager and submitted by the senior site executive to the lead Secretarial Officer for approval
   b. The proposed activity has been jointly approved by the Secretarial Officer and the Assistant Secretary for Environment, Safety and Health.

4. Emergency exposure limits are not Planned Special Exposure limits. Guidelines for emergency exposures are provided in Appendix 2A.

5. The radiological worker dose limits provided in Table 2-1 also apply to general employees. 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 mrem in one year. General employees who have not received Radiological Worker I or II training are not normally expected to exceed 100 mrem in a year.

Table 2-1 Summary of Dose Limits

Exposures shall be well 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
Radiological Worker*:	Whole Body (internal + external)	5 rem
Radiological Worker*:	Lens of Eye	15 rem
Radiological Worker*:	Extremity (hands and arms below the elbow; feet and legs below the knees)	50 rem
Radiological Worker*:	Any organ or tissue (other than lens of eye) and skin	50 rem
Declared Pregnant Worker:	Embryo/Fetus	0.5 rem per gestation period
Minors and Students: (under age 18)	Whole Body (internal + external)	0.1 rem
Visitors** and Public:	Whole Body (internal + external)	0.1 rem

* Radiological Workers are General Employees authorized unescorted access to radiological areas per Articles 332, 334, and 335.

** Applies to visitors who have not completed training in accordance with Articles 632 or 633 or have not met the special considerations of Article 657.

Notes:

1. Internal dose to the whole body shall be calculated as committed effective dose equivalent. The committed effective dose equivalent is the resulting dose committed to the whole body from internally deposited radionuclides over a 50-year period after intake. See Appendix 2B for the weighting factors to be used in converting organ dose equivalent to effective dose equivalent for the whole body dose.

2. The annual limit of exposure to "any organ or tissue" is based on the committed dose to that organ or tissue resulting from internally deposited radionuclides over a 50-year period after intake plus any external effective dose equivalent to that organ during the year.

3. Exposures due to background radiation, therapeutic and diagnostic medical procedures, and voluntary participation in medical research programs shall not be included in either personnel radiation dose records or assessment of dose against the limits in this Table.

4. See Appendix 2C for guidance on non-uniform exposure of the skin.

214 Visitor Dose Limit

Visitors to DOE sites shall be limited to an annual radiation dose of 100 mrem from the sum of internal and external radiation sources unless they either qualify as radiological workers in accordance with Article 632 or 633, or meet the special considerations of Article 657.

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. This declaration may be revoked, in writing, at any time by the declared pregnant worker.

1. The employer shall 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 dose limit for the embryo/fetus from conception to birth (entire gestation period) is 500 mrem
   b. Measures shall be taken to avoid substantial variation above the uniform exposure rate necessary to meet the 500 mrem limit for the gestation period. Efforts should be made to avoid exceeding 50 mrem per month to the declared pregnant worker.

3. If the dose to the embryo/fetus is determined to have already exceeded 500 mrem when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks where additional occupational radiation exposure is likely during the remainder of the gestation period.

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 contractor senior site executive should obtain advice from professionals in other disciplines such as human resources and legal in establishing Special Control Levels. The contractor senior site executive may wish to establish these Special Control Levels using a radiological health advisory group.

1. A Special Control Level for annual occupational exposure shall 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 shall 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.

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. Personnel exiting Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas or Radiological Buffer Areas established for contamination control shall frisk for 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.

2. Monitoring for contamination should be performed using frisking equipment that under laboratory conditions can detect total contamination of at least the values specified in Table 2-2. Use of automatic monitoring units that meet the above requirements is encouraged.

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 shall 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 be posted as specified in Article 235.

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 shall not be applied without the approval of the Radiological Control Manager.

3. In addition to the posting criteria in Article 235, the conditions for establishing and maintaining Fixed Contamination Areas include all of the following:

   a. Radiological surveys shall be performed to detect contamination that may become removable over time
   b. A formal inventory shall be maintained of Fixed Contamination Areas.
   c. Markings shall be kept legible
   d. Removable contamination shall 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. Markings should include the standard radiation symbol, be clearly visible from all directions and contrast with the colors of the surface coatings
   g. Additional coating should be applied when the bottom color appears
   h. A plan for identifying and adding to the inventory of existing areas of fixed contamination not included in the initial inventory should be developed.

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 mrem 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.

6. For contaminated soil that is not releasable in accordance with DOE 5400.5, a Soil Contamination Area shall be established that:

   a. Is posted as specified in Article 235. Posting should include instructions or special warnings to workers such as "Consult With Radiological Control Organization Before Digging" or "Subsurface Contamination Exists"
   b. Meets the requirements of Article 231.1 through 231.8.

7. Soil Contamination Areas may be located outside a Radiological Buffer Area.

223 Airborne Radioactivity Control Levels

1. 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.

2. Occupied areas with airborne concentrations of radioactivity that are greater than or potentially greater than 10 percent of a Derived Air Concentration shall be posted as specified in Article 235. For most radionuclides, air containing 10 percent of a Derived Air Concentration results in a committed effective dose equivalent of approximately 10 mrem if inhaled continuously for one work week. Values of Derived Air Concentrations are provided in 10 CFR 835.

Table 2-2 Summary of Contamination Values

NUCLIDE (See Note 1)	REMOVABLE (dpm/100 cm^2) (See Note 2)	TOTAL (FIXED + REMOVABLE) (dpm/100 cm^2) (See Note 3)
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-125, 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. Includes mixed fission products containing Sr-90.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO and metal tritide aerosols	10,000	10,000

Notes:

1. The values in this Table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha-and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231 and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over 1 square meter provided the maximum activity in any area of 100 cm^2 is less than three times the values in Table 2-2.

PART 3 Posting

231 Posting Requirements

1. Radiological posting shall be 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 depicted in Figure 2-1.

2. Signs shall contain the standard radiation symbol colored magenta or black on a yellow background. Lettering shall be either magenta or black. Magenta is the preferred color over black. Standardized signs, as described in the standardized core training, shall be used where practicable.

3. Signs shall be conspicuously posted, clearly worded, and, where appropriate, may include radiological control instructions. Radiological postings should be displayed only to signify actual or potential radiological conditions. Signs used for training should be clearly marked, such as "For Training Purposes Only."

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

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

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

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

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 and similar barriers used to designate the boundaries of posted areas should be yellow and magenta in color.

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

11. Posting of doors should be such that the postings remain visible when doors are open or closed.

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."

232 Posting Controlled Areas

1. Each access point to a Controlled Area shall be posted, identifying it as a Controlled Area, whenever radioactive materials or radiation fields which would require posting under Articles 234 or 235 (except for Fixed Contamination Areas) may be present in the area. Persons who enter only the Controlled Area without entering Radiation, Contamination, Airborne Radioactivity or Radiological Buffer Areas are not expected to receive more than 100 mrem in a year.

2. The contractor may select the type of sign used to avoid conflict with local security requirements. This selection shall be approved by the site senior executive.

233 Posting Radiological Buffer Areas

Radiological Buffer Areas shall 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.

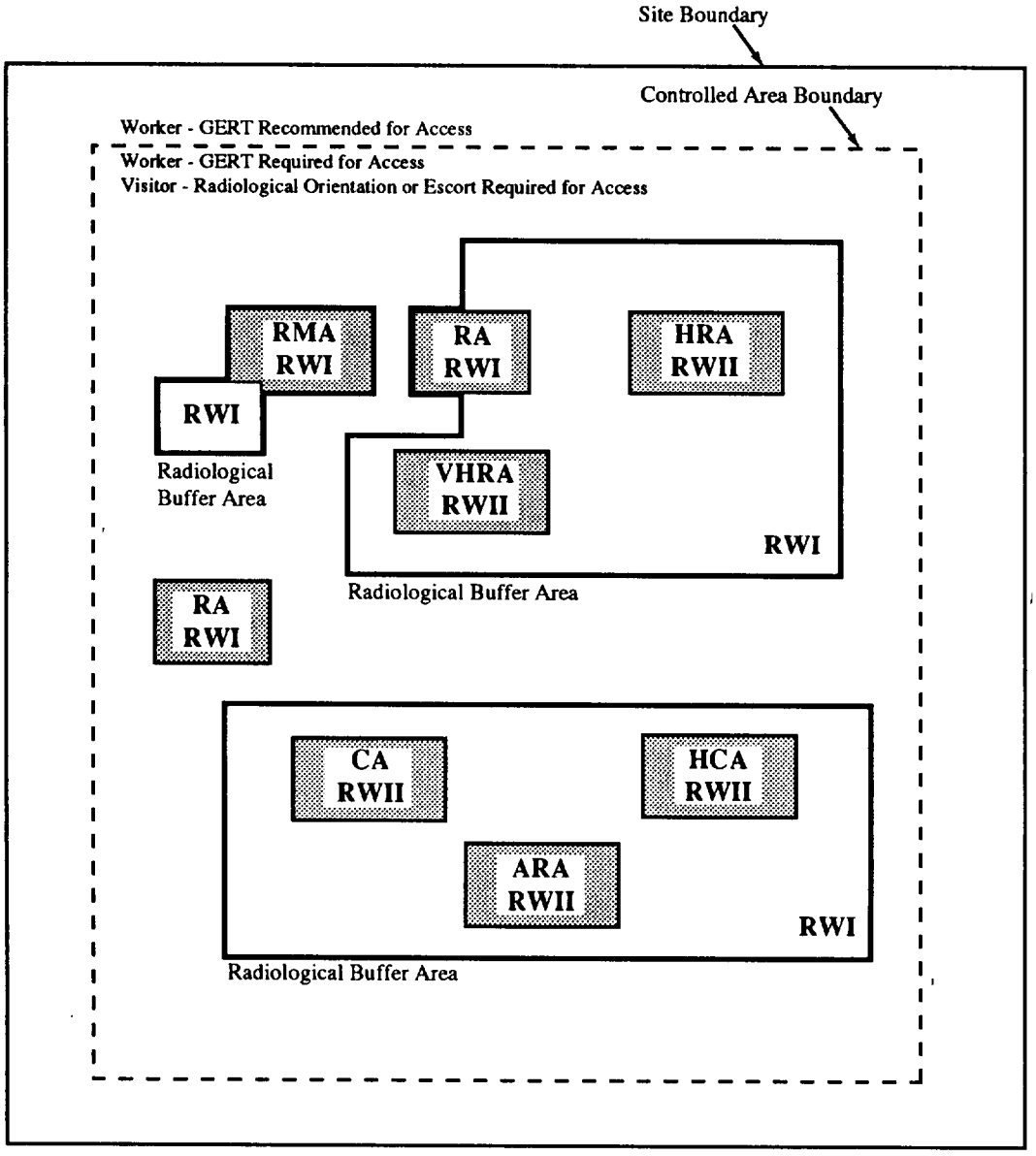
1. The size of the Radiological Buffer Area should be commensurate with the potential for the spread of contamination outside Contamination, High Contamination and Airborne Radioactivity Areas. At a minimum, the Radiological Buffer Area should include the area adjacent to any exit from and entrance to Contamination, High Contamination and Airborne Radioactivity Areas.

2. A Radiological Buffer Area is not required for High Contamination Areas or Airborne Radioactivity Areas that are completely within Contamination Areas.

3. A Radiological Buffer Area established to limit exposure to external radiation should surround Radiation, High Radiation and Very High Radiation Areas. The boundary for the Radiological Buffer Area should be established to limit radiation doses to general employees to less than 100 mrem per year. 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 shall be in accordance with Article 231 and shall contain the wording "CAUTION, RADIOLOGICAL BUFFER AREA."

Figure 2-1
Establishing Posted Areas



Legend:

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

234 Posting Radiation Areas

1. Areas shall be posted to alert personnel to the presence of external radiation in accordance with Table 2-3 and Article 231.

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 100 cm.

3. Contact readings should be used to determine the need for posting 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 should not be required.

4. A label marking the location of the Hot Spot should be placed on or as near the spot as practical. The provisions of Article 231.7 through 231.11 do not apply to the Hot Spot posting. Posting of Hot Spots is not required in areas with general area dose rates greater than 1 rem/hr.

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 received in an hour may be used as the criterion for posting (Column 2 of Table 2-3). In this table, the unit "rad" is associated with dose rates that pose an immediate danger.

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	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 be posted to alert personnel to contamination in accordance with Table 2-4 and Article 231.

2. The requirement for an RWP should be included either on or in conjunction with each posting as applicable.

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.

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

AREA	CRITERIA	POSTING
Contamination	Contamination levels (dpm/100 cm^2) > 1 time but ≤ 100 times Table 2-2 values	"CAUTION, CONTAMINATION AREA"
High Contamination	Contamination levels (dpm/100 cm^2) > 100 times Table 2-2 values	"DANGER, HIGH CONTAMINATION AREA" "RWP Required for Entry"
Fixed Contamination	Removable contamination levels < Table 2-2 removable values and total contamination levels > Table 2-2 total values	"CAUTION, FIXED CONTAMINATION"
Soil Contamination	Contaminated soil not releasable in accordance with DOE 5400.5	"CAUTION, SOIL CONTAMINATION AREA"
Airborne Radioactivity	Concentrations (μCi/cc) > 10% of any DAC value	"CAUTION, AIRBORNE RADIOACTIVITY AREA" "RWP Required for Entry"

236 Posting Radioactive Material Areas

1. Areas where radioactive materials are used, handled or stored should be posted "CAUTION, RADIOACTIVE MATERIAL." The posting shall meet the requirements in Article 231.

2. Radioactive Material Areas should be located within Controlled Areas.

3. Radioactive Material Areas are not required when the radioactive material in any one location:

   a. Consists of ten or less sealed sources with half-lives less than 30 days or activities less than those specified in Table 1 of DOE N 5400.9 (Extended by DOE N 5400.10)

   b. Is inside a Contamination, High Contamination, or Airborne Radioactivity Area.

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

237 Posting Underground Radioactive Material Areas

1. Underground Radioactive Material Areas shall be established to indicate the presence of underground items that contain radioactive materials such as pipelines, radioactive cribs, covered ponds, covered ditches, catch tanks, inactive burial grounds, and sites of known, covered, unplanned releases (spills).

2. Underground Radioactive Material Areas shall 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 shall 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 mrem/year 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 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.

Appendix 2A

Guidelines for Control of Emergency Exposures

In extremely rare cases, emergency exposure to radiation may be necessary to rescue personnel or to protect major property. Emergency exposures may be authorized in accordance with the provisions contained in 10 CFR 835. These doses are in addition to and accounted for separately from the doses received under the limits in Table 2-1. The dose limits for personnel performing these operations are listed below.

DOSE LIMIT (Total Effective Dose Equivalent)	ACTIVITY PERFORMED	CONDITIONS
5 rems	All	
10 rems	Protecting major property	Only on a voluntary basis where lower dose limit not practicable
25 rems	Lifesaving or protection of large populations	Only on a voluntary basis where lower dose limit not practicable
>25 rems	Lifesaving or protection of large populations	Only on a voluntary basis to personnel fully aware of the risks involved

Notes:

1. The lens of the eye dose limit should be three times the listed values.

2. The shallow dose limit to the skin of the whole body and the extremities is ten times the listed values.

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Appendix 2B

Weighting Factors for Organs and Tissues

ORGANS OR TISSUES	WEIGHTING FACTOR
Gonads	0.25
Breasts	0.15
Red bone marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30
Whole Body	1.00

Notes:

1. Weighting factors as defined in ICRP Publication 26 and NCRP Report 91 are used to convert organ or tissue dose equivalent to effective dose equivalent for the whole body. The effective dose equivalent is obtained by multiplying the organ dose by the weighting factor. For example, a 5 rem dose to the thyroid would be multiplied by the weighting factor 0.03 to yield 0.15 rem.

2. "Remainder" means the five other organs or tissues with the highest dose (e.g. liver, kidney, pancreas, stomach, small intestine and upper large intestine). The weighting factor of 0.3 results from 0.06 for each of the five remainder organs.

3. For the case of uniform external irradiation of the whole body, a weighting factor equal to 1 may be used in the determination of the effective dose equivalent.

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Appendix 2C

Non-Uniform Exposure of the Skin

Non-uniform exposures of the skin from x-rays, beta radiation and radioactive materials on the skin, including hot particles shall be assessed and recorded as specified in the table below:

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

CHAPTER 3 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, shall incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. The primary methods used to maintain exposures ALARA shall be facility and equipment design features. These features may be augmented by administrative and procedural requirements. 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 shall 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 nonradiological 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. The Site-Specific Radiological Control Manual shall establish trigger levels requiring formal radiological review of nonroutine or complex work activities. These appropriate trigger levels should include:

   a. Estimated individual or collective dose greater than preestablished values
   b. Predicted airborne radioactivity concentrations in excess of preestablished values
   c. Work area removable contamination greater than 100 times the values in Table 2-2
   d. Entry into areas where dose rates exceed 1 rem/hour
   e. Potential radioactive releases to the environment.

4. Tasks with the potential to exceed the above trigger levels shall undergo a formal, documented radiological or ALARA review. At a minimum, this review should consider the following:

   a. Inclusion of Radiological Control Hold Points in the technical work documents
   b. Elimination or reduction of radioactivity through line flushing and decontamination
   c. Use of work processes and special tooling to reduce time in the work area
   d. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity
   e. Specification of special radiological training or monitoring requirements
   f. Use of mock-ups for high exposure or complex tasks
   g. Engineering, design and use of temporary shielding to reduce radiation levels
   h. Walkdown or dry-run of the activity using applicable procedures
   i. Staging and preparation of necessary materials and special tools
   j. Maximization of prefabrication and shop work
   k. Review of abnormal and emergency procedures and plans
   l. Identification of points where signatures and second party or independent verifications are required
   m. Establishment of success or completion criteria, with contingency plans to anticipate difficulties
   n. Development of a pre-job estimate of collective dose to be incurred for the job
   o. Provisions for waste minimization and disposal.

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

6. Radiological work anticipated to exceed individual or collective dose criteria established in the Site-Specific Radiological Control Manual should be reviewed and approved by the ALARA Committee.

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

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

3. Review and approval by the ALARA Committee

4. Enhanced line and Radiological Control 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. Site procedures may identify specific shielding applications, such as the shielding of low activity sources or samples, that fall outside the recommendations of this Article.

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 of 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.

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, should be the primary method of minimizing airborne radioactivity and internal exposure to workers.

2. Administrative controls, including access restrictions and the use of specific work practices designed to minimize airborne contamination, should be used as the secondary method to minimize worker internal exposure.

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 posted Airborne Radioactivity Areas
    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
    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.

PART 2 Work Preparation

321 Radiological Work Permits

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. The RWP should include the following information:

1. Description of work
2. Work area radiological conditions
3. Dosimetry requirements
4. Pre-job briefing requirements, as applicable
5. Training requirements for entry
6. Protective clothing and respiratory protection requirements
7. Radiological Control coverage requirements and stay time controls, as applicable
8. Limiting radiological conditions that may void the RWP
9. Special dose or contamination reduction considerations
10. Special personnel frisking considerations
11. Technical work document number, as applicable
12. Unique identifying number
13. Date of issue and expiration
14. Authorizing signatures.

322 Use of Radiological Work Permits

1. RWPs shall 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 Airborne Radioactivity Areas.

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

   a. Entry into Radiation Areas
   b. Entry into Contamination Areas
   c. Handling of materials with removable contamination that exceed the values of Table 2-2.

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

4. General RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with well-characterized and stable radiological conditions. General RWPs should not be approved for periods longer than 1 year.

5. Radiological surveys shall be routinely reviewed to evaluate adequacy of RWP requirements. RWPs shall be updated if radiological conditions change to the extent that protective requirements need modification.

6. RWPs should be posted at the access point to the applicable radiological work area.

7. Workers shall 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.

8. Worker pocket or electronic dosimeter readings should be recorded in a format that identifies and provides linkage to the applicable RWP.

9. 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.

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 shall be reviewed and approved by the Radiological Control Organization.

3. The RWP shall be based on current radiological surveys and anticipated radiological conditions.

4. The RWP shall be approved by the supervisor responsible for the work or area and the appropriate Radiological Control supervisor. Revisions or extensions to RWPs shall 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. Radiologically limiting conditions, such as contamination or radiation levels that may void the RWP
   f. Radiological Control Hold Points
   g. Communications and coordination with other groups
   h. Provisions for housekeeping and final cleanup
   i. Emergency response provisions.

3. Pre-job briefings should be conducted by the cognizant work supervisor.

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

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.

325 Personal Protective Equipment and Clothing

1. Personnel shall wear protective clothing during the following activities:

   a. Handling of contaminated materials with removable contamination in excess of Table 2-2 levels
   b. Work in Contamination, High Contamination and Airborne Radioactivity Areas
   c. As directed by the Radiological Control Organization or as required by the RWP.

2. Protective clothing and shoes designated for radiological control shall 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 shall be selected as prescribed by the controlling RWP. General guidelines for protective clothing selection and use are provided in Appendix 3C and in Table 3-1.

5. The use of labcoats as radiological protective clothing is appropriate for limited applications such as those discussed in Appendix 3C where the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Labcoats should not be used as protective clothing for performing physical work activities in Contamination, High Contamination or Airborne Radioactivity Areas.

6. Instructions for donning and removing protective clothing should be posted at the dress-out and step-off pad areas.

7. The use of Personal Protective Equipment or Clothing (including respiratory protection) beyond that authorized by the Radiological Control Organization detracts from work performance and is contrary to ALARA principles and waste minimization practices. Such use should not be authorized.

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.

PART 3 Entry and Exit Requirements

331 Controlled Areas

Successful completion of Visitor Orientation or General Employee Radiological Training is required for unescorted entry into Controlled Areas.

332 Radiological Buffer Areas

1. Minimum requirements for unescorted entry into Radiological Buffer Areas shall include the following:

   a. Radiological Worker I training
   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 Radioactive Material Areas

1. Radiological Worker I training shall be required for unescorted entry into Radioactive Material Areas containing either of the following:

   a. Sealed radioactive sources
   b. Radioactive material labeled and packaged in accordance with Articles 412 and 413

2. Entry into Radioactive Material Areas where whole body dose rates exceed 5 mrem/hr or removable contamination levels exceed Table 2-2 values shall be in accordance with the requirements of Articles 334.1 and 335.1, respectively.

334 Radiation, High Radiation and Very High Radiation Areas

1. Minimum requirements for unescorted entry into Radiation Areas shall include the following:

   a. Radiological Worker I training
   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 and Very High Radiation Areas shall be maintained in accordance with Appendix 3B.

3. Minimum requirements for unescorted entry into High Radiation Areas shall include the following:

   a. Radiological Worker II training (or Radiological Worker I with High/Very High Radiation Area access training in accordance with Article 632.5) 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. Personnel and supplemental dosimeters
   d. Survey meter or dose rate indicating device available at the work area.

4. Minimum requirements for unescorted entry into High Radiation Areas where dose rates exist such that a worker could exceed a whole body dose of 1 rem in one hour shall include those items listed in Article 334.3 and the following:

   a. A determination of the worker's current exposure, based on primary and supplemental dosimeter readings
   b. Pre-job briefing, as applicable
   c. Review and determination by the Radiological Control Organization regarding the required level of Radiological Control Technician coverage.

5. Workers shall be prevented from entry to Very High Radiation Areas when the radiation source is exposed and very high radiation fields are present. In addition to the controls required in Articles 334.2 and 334.3, a survey shall be made prior to the first entry to the area after the source has been secured or shielded to verify the very high radiation field has been terminated.

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 be strictly controlled where locked entryways are used to control access to High and Very High Radiation Areas.

8. The Radiological Control Organization should maintain an inventory of High and Very High Radiation Areas.

9. Weekly inspections of the physical access controls to High and Very High Radiation Areas should be made to verify controls are adequate to prevent unauthorized entry.

10. Administrative procedures shall be developed as necessary to implement area access controls. These procedures shall address measures implemented to ensure the effectiveness and operability of entry control devices, such as barricades, alarms, and locks.

335 Contamination, High Contamination and Airborne Radioactivity Areas

1. Minimum requirements for unescorted entry into Contamination Areas shall include the following:

   a. Radiological Worker II training
   b. Worker's signature on the RWP, as applicable
   c. Protective clothing
   d. Personnel dosimetry, as appropriate.

2. Minimum requirements for unescorted entry into High Contamination or Airborne Radioactivity Areas shall include the following:

   a. Radiological Worker II training
   b. Worker's signature on the RWP
   c. Protective clothing and respiratory protection when specified by the RWP
   d. Pre-job briefing for High Contamination or Airborne Radioactivity Areas, as applicable
   e. Personnel dosimetry, as appropriate.

3. Personnel exiting Contamination, High Contamination or Airborne Radioactivity Areas shall:

   a. Remove protective clothing as specified in Appendix 3C
   b. 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 should include the following:

   a. Step-off pad located outside the exit point, contiguous with the area boundary
   b. Step-off pads maintained free of radioactive contamination
   c. Labeled containers inside the area boundary for the collection of protective clothing and equipment
   d. Contamination monitoring equipment located as close to the step-off pad as background radiation levels permit.

5. Multiple step-off pads should be used at the exits from High Contamination Areas. Use of multiple step-off pads is described in Appendix 3C.

6. Protective clothing and monitoring 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 be monitored for release in accordance with Article 421 or for retention in the contaminated tool crib in accordance with Article 442.5.

8. Administrative procedures shall be developed as necessary to implement area access controls. These procedures shall address measures implemented to ensure the effectiveness and operability of entry control devices, such as barricades, alarms, and locks.

336 Visitor Entry Requirements

1. Site procedures shall identify area entry requirements and access restrictions for visitors.

2. Visitors 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

3. Visitors shall 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 visitors are identified in Articles 622 and 657.

337 Controlling the Spread of Contamination

The following measures should be used 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

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

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

338 Monitoring for Personnel Contamination

1. Personnel shall perform a whole body frisk under the following conditions:

   a. Immediately upon entry into an uncontaminated area after exiting Contamination Areas, High Contamination Areas and Airborne Radioactivity Areas
   b. As directed by the RWP or the Radiological Control Organization.

2. In addition to the above, personnel exiting a Radiological Buffer Area containing Contamination, High Contamination or Airborne Radioactivity Areas should, at a minimum, perform a hand and foot frisk. This frisk is optional if the Radiological Buffer Area exit is immediately adjacent to the location where the exiting 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 shall:

   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 shall be performed after removal of protective clothing and prior to washing or showering.

5. Personnel frisking shall 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. Personal items, such as notebooks, papers and flashlights, shall be subject to the same frisking requirements as the person carrying them.

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.

PART 4 Radiological Work Controls

341 Requirements

1. Radiological work activities shall be conducted as specified by the controlling technical work document and Radiological Work Permit.

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 be monitored and maintained ALARA. Work should be curtailed and decontamination performed at preestablished 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. Requirements for area cleanup should be included in the technical work documents. Work activities should not be considered complete until support material and equipment have been removed and the area has been returned to at least prework status.

11. To minimize intakes of radioactive material by personnel, smoking, eating, or chewing shall 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:

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

343 Logs and Communications

1. Radiological Control personnel should maintain logs to document radiological occurrences, status of work activities and other relevant information.

2. During continuous or extended daily operations, 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.

345 Stop Radiological Work Authority

1. Radiological Control Technicians and their supervisors, line supervision, and any worker through their supervisor has 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
   c. Radiological Control Hold Point not being satisfied.

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

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

4. Resumption of radiological work requires the approval of the line manager responsible for the work and the Radiological Control Manager.

346 Response to Abnormal Situations

1. The Site-Specific Radiological Control Manual or procedures for responding to abnormal situations shall 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
   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
   d. Notify Radiological Control personnel.

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

   a. Immediately evacuate the area, without stopping to remove protective clothing or perform exit monitoring
   b. Report to designated assembly area.

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

   a. Remain in the immediate area
   b. Notify Radiological Control personnel
   c. Take actions that may be available to minimize cross-contamination, such as putting a glove on a contaminated hand
   d. Take follow-up actions in accordance with Article 541.

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

   a. Stop or secure the operation causing the spill
   b. Warn others in the area
   c. Isolate the spill area if possible
   d. Minimize individual exposure and contamination
   e. Secure unfiltered ventilation
   f. Notify Radiological Control personnel.

   For spills involving highly toxic chemicals, workers should immediately exit the area without attempting to stop or secure the spill. They should then promptly notify the Industrial Hygiene or Hazardous Material team and Radiological Control personnel.

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 shall, at a minimum, include labcoats and gloves. Gloves should be secured at the wrist as necessary.
   b. Shoecovers should be considered based on the potential for floor contamination.
   c. Workers should periodically monitor their hands during work.
   d. Upon completion of work or prior to leaving the area, workers shall 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.

3. The following controls apply to sample station operations:

   a. Protective clothing shall, at a minimum, include labcoats and gloves. Gloves should be secured at the wrist as necessary.
   b. Shoecovers should be considered based on the potential for floor contamination.
   c. 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.
   d. Workers should periodically monitor their hands during work.

   e. Upon completion of work or prior to leaving the area, workers shall 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.

4. The following controls apply to glovebox operations:

   a. Gloveboxes should be inspected for integrity and operability prior to use.
   b. Gloveboxes should be marked with or survey measurements should be posted to identify whole body and extremity dose rates.
   c. Protective clothing shall, at a minimum, include labcoats and gloves. Gloves should be secured at the wrist as necessary.
   d. Shoecovers should be considered based on the potential for floor contamination.
   e. Workers should periodically monitor their hands during work.
   f. Upon completion of work or prior to leaving the area, workers shall monitor those areas of their body that are potentially contaminated. At a minimum, this includes hands, arms, and feet. Workers should perform a whole body frisk.

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. The Site-Specific Radiological Control Manual should define hot particles, such as those capable of producing a shallow dose equivalent greater than 100 mrem in one hour, specific to facility operations and source terms.

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

   a. Upon identification of hot particles
   b. During new or nonroutine operations with a high potential for hot particles, based on previous history
   c. Upon direction of the Radiological Control Organization.

3. Areas or operations with the potential for hot particle contamination should be surveyed in accordance with Article 554.7.

4. Contamination Area posting should be annotated to specifically identify the presence of hot particles.

5. Access to hot particle areas should be controlled by a job-specific 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
   d. Use of sticky pads or multiple step-off pads.

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

7. Response to hot particle skin 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
   d. Evaluation of work control adequacy.

PART 5 Evaluation of Performance

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

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

351 Conduct of Critiques

Critiques are meetings of the 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. At a minimum, the general critique process should include the following elements:

   a. Formal meetings, chaired by a critique leader
   b. Attendance by all who can contribute
   c. Personal statement forms completed by selected personnel before the meeting
   d. Attendance records
   e. Minutes, recorded and signed by the critique leader and all contributors
   f. Personal statements, signed and attached to the meeting minutes
   g. A listing of the facts in chronological order
   h. Supporting materials, including documents, records, photographs, parts and logs, maintained by the critique leader.

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

352 Post-Job Reviews

Performance should be reviewed after completion of nonroutine radiological work. Requirements for post-job reviews should be delineated in the Site-Specific Radiological Control Manual.

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.

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

There is the perception that exposure to small quantities of plutonium presents greater risk than exposure to other radionuclides. Low levels of plutonium in the body are difficult to measure and biological removal processes for plutonium are slow. For these reasons:

1. Primary emphasis shall be placed on engineered features to contain plutonium and to prevent airborne and surface contamination.

2. In addition to the provisions of this Manual, guidance contained in the document, "Health Physics Manual of Good Practices for Plutonium Facilities," PNL-6534, should be considered for plutonium operations in preparing the Site-Specific Radiological Control Manual. This manual provides specific guidance related to dosimetry, radiological monitoring, instrumentation, contamination control, and applicable radiological control procedures.

362 Uranium Operations

Natural, depleted, and low-enriched uranium are unusual in that their chemical toxicity is more limiting in the human body than their radioactivity. Also, processed uranium sometimes contains transuranic and other radionuclides from recycled materials.

For these reasons, in addition to the provisions of this Manual, the guidance contained in the document, "Health Physics Manual of Good Practices for Uranium Facilities," EG&G-2530, should be considered for uranium operations in preparing the Site-Specific Radiological Control Manual. This manual provides specific guidance related to management controls, radiological monitoring, contamination control, and internal and external exposure controls.

363 Tritium Operations

The following characteristics of tritium require consideration in the implementation of the Radiological Control Program at tritium facilities:

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

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

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

4. Due to its high permeability, tritium is difficult to contain. Special attention should be directed to the selection of Personal Protective Equipment and Clothing.

For the above reasons, guidance contained in the document, "Health Physics Manual of Good Practices at Tritium Facilities," MLM-3719, should be considered for tritium operations in preparing the Site-Specific Radiological Control Manual. This manual provides specific guidance related to internal dosimetry, contamination and air monitoring, tritium containment practices and techniques and Personal Protective Equipment and Clothing selection.

364 Accelerator Operations

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

1. In addition to the provisions of this Manual, guidance contained in the document, "Health Physics Manual of Good Practices for Accelerator Facilities," SLAC-327, should be considered for accelerator operations in preparing the Site-Specific Radiological Control Manual. This manual provides specific guidance related to radiological monitoring, dosimetry, shielding design, use of interlocks, and procedures and administrative controls.

2. Consideration should be given to the information provided in DOE Order 5480.25, "Safety of Accelerator Facilities," in preparing the Site-Specific Radiological Control Manual.

3. Safety devices and interlocks shall be operational prior to and during operation of a beam. Operational status shall be verified by testing.

365 Radiation Generating Devices

Special considerations associated with the use of radiation generating devices include the presence of extremely high dose rates and the potential for uncontrolled exposures. Operation of these devices requires stringent physical and administrative controls to prevent overexposure to operating and support personnel and those in adjacent work areas. The Site-Specific Radiological Control Manual shall contain the following provisions for applicable types of radiation generating devices.

1. DOE 5480.4 mandates the use of ANSI N43.3 entitled, "American National Standard for General Radiation Safety-Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV," for operations involving the irradiation of materials.

2. DOE 5480.4 mandates the use of ANSI N43.2 entitled, "Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment," for operations involving the following devices:

   a. Analytical diffraction and fluorescence
   b. Flash x-ray
   c. Sealed source irradiators used for diffraction studies.

3. Line management in conjunction with the Radiological Control Organization shall establish the radiological control requirements for incidental x-ray devices such as electron microscopes and electron beam welders.

4. Devices for medical use shall 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. DOE 5480.4 mandates the use of ANSI N43.3 entitled, "American National Standard for General Radiation Safety-Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV," for on-site operations with devices other than sealed sources.

c. On-site operations conducted by off-site contractors shall be approved by line management in coordination with the site Radiological Control Organization. This process shall ensure the contractor has a valid Nuclear Regulatory Commission or Agreement State license and that the operational and emergency procedures are current and available.

6. Safety devices and interlocks at fixed installations shall be operational prior to and during generation of a radiation field. Operational status shall be verified by testing.

PART 7 Construction and Restoration Projects

Construction and restoration projects, including decontamination and decommissioning (D&D), remedial action, or other actions involving materials which contain low levels of radioactivity may present special problems and require site-specific or program-specific control methods. Health and Safety Plans are normally developed to specify controls for all types of restoration programs including Formerly Utilized Sites Remedial Action Program (FUSRAP), Uranium Mill Tailings Remedial Action (UMTRA) and other restoration projects.

371 Requirements

Radiological operations and work activities at construction and environmental restoration projects shall be conducted in accordance with this Manual. In light of the special nature of these activities, which typically involve low-levels of radioactivity and the use of heavy construction or earth-moving equipment, these projects require some radiological considerations different from other activities governed by this Manual.

For the following specific subject areas, the radiological requirements of this Manual may be modified by the limited application of the provisions of Article 113.3. The Radiological Control Manager is authorized to change mandatory "shall" requirements to "should" to facilitate implementation of radiological controls in the following specific subject areas. The contractor has the responsibility to document the technical equivalency of alternative solutions.

1. Performance goals and indicators appropriate to remedial activities

2. Personal Protective Equipment requirements and practices to accommodate other hazards on the site

3. Use of respiratory protection as normal conduct of operation due to lack of engineering controls and temporary nature of the work

4. Use of Contamination Reduction Corridors to accommodate movement of personnel and heavy equipment through a variety of decontamination stations

5. Methods to obtain representative samples for release of equipment and material from the work areas

6. Surveying of materials released from Soil Contamination Areas that exhibit significant contamination transfer properties

7. Precedence of state and Federally mandated soil cleanup criteria over surface contamination criteria that otherwise apply

8. Monitoring and survey frequency for inactive facilities or large areas that are infrequently occupied

9. Outdoor storage of uncontained, bulk radioactive materials such as contaminated soil

10. Postings of privately owned and adjacent property

11. Evaluation of outdoor air monitoring methodologies that take into account dust loading, environmental factors, and supplemental breathing zone sampling

12. Criteria for suspension of operations under inclement conditions, such as wind or rain.

372 Environmental Conditions

Inclement weather or other environmental conditions may disrupt radiological controls. If that occurs, the following actions should be considered:

1. The use of covers, wind screens and runoff collection basins to preclude the inadvertent spread of radioactive material

2. Provisions for worksite personnel to assemble and be monitored prior to release or reestablishment of work

3. Evaluation of work area to determine if a need exists for modified work controls or decontamination.

373 Other Workplace Hazards

Radiological controls should be implemented in a balanced way to ensure that protection from all workplace hazards can be implemented. Other hazards to consider include:

1. General construction hazards

2. Confined spaces

3. Flammable materials

4. Reactive chemicals

5. Heat stress
6. Chemical exposures
7. Energized electrical equipment
8. Biological hazards
9. Rotating equipment
10. Noise and vibration
11. Excavations.

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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
- 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 features should be used for each entrance or access point to a High Radiation Area and shall be used for each entrance or access point to a High Radiation Area where radiation levels exist such that a person could exceed a whole body dose of 1 rem in any one hour:

   a. A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a High Radiation Area

   b. A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area

   c. A control device that energizes a conspicuous visible or audible alarm signal so that the person entering the High Radiation Area and the supervisor of the activity are made aware of the entry

   d. Entryways that are locked, except during periods when access to the area is required, with positive control over each entry

   e. Continuous direct or electronic surveillance that is capable of preventing unauthorized entry

   f. A control device that automatically generates audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

2. In addition to the above requirements, additional measures shall be implemented to ensure personnel are not able to gain access to Very High Radiation Areas when dose rates are in excess of the posting requirements of Table 2-3.

3. Physical access controls over High and Very High Radiation Areas shall be established in such a way that does not prevent a person from leaving the area.

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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 nonradiological hazards that may be present. Table 3-1 provides general guidelines for selection. As referenced in the table, a full set and double set of protective clothing typically includes:

   Full Set of PCs
   a. Coveralls
   b. Cotton glove liners
   c. Gloves
   d. Shoe covers
   e. Rubber overshoes
   f. Hood

   Double Set of PCs
   a. Two pairs of coveralls
   b. Cotton glove liners
   c. Two pairs of gloves
   d. Two pairs of shoe covers
   e. Rubber overshoes
   f. Hood

3. Cotton glove liners may be worn inside standard gloves for comfort, but should not be worn alone or considered as a layer of protection.

4. Shoecovers and gloves should be sufficiently durable for the intended use. Leather or canvas work gloves should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.

5. Use of hard hats in Contamination Areas should be controlled by the Radiological Work Permit. Hard hats designated for use in such areas should be distinctly colored or marked.

6. Shoe covers and gloves should be secured or taped at the coverall legs and sleeves when necessary to prevent worker contamination. Tape should be tabbed to permit easy removal.

7. Supplemental pocket or electronic dosimeters should be worn outside the protective clothing, in a manner accessible to the worker. Workers should protect such dosimeters from contamination by placing them in an outer coverall pocket or in plastic bags or pouches.

8. Outer personal clothing should not be worn under protective clothing for entry to High Contamination Areas or during work conditions requiring a double set of protective clothing.

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, the worker should:

1. Remove exposed tape
2. Remove rubber overshoes
3. Remove gloves
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove coveralls, inside out, touching inside only
7. Take down barrier closure, as applicable
8. Remove tape or fastener from inner shoe cover
9. Remove each shoe cover, placing shoe onto clean step-off pad
10. Remove cloth glove liners
11. Replace barrier closure, as applicable
12. Commence whole body frisking
13. Monitor badge and dosimeter.

The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination.

Sequence for Removing a Double Set of Protective Clothing using Two Step-Off Pads

Before stepping to the inner step-off pad, the worker should:

1. Remove exposed tape
2. Remove rubber overshoes
3. Remover outer gloves
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove outer coverall, inside out, touching inside only
7. Remove tape from inner coverall and sleeves
8. Remove each outer shoe cover, stepping on inner step-off pad as each is removed.

Before stepping to the outer step-off pad, the worker should:

9. Remove inner rubber gloves
10. Remove inner coveralls, inside out, touching inside only
11. Take down barrier closure, as applicable
12. Remove tape or fastener from inner shoe cover
13. Remove each inner shoe cover, placing shoe on clean outer step-off pad
14. Remove cotton glove liners
15. Replace barrier closure, as applicable
16. Commence whole body frisking
17. Monitor badge and dosimeter.

The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination.

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.

Table 3-1 Guidelines for Selecting Protective Clothing (PC)

WORK ACTIVITY	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)
Routine	Full set of PCs	Full set of PCs	Full set of PCs, double gloves, double shoecovers
Heavy work	Full set of PCs, work gloves	Double set of PCs, work gloves	Double set of PCs, work gloves
Work with pressurized or large volume liquids, closed system breach	Full set of non-permeable PCs	Double set of PCs (outer set non-permeable), rubber boots	Double set of PCs and non-permeable outer clothing, rubber boots

Note:

For hands-off tours or inspections in areas with removable contamination at levels 1 to 10 times the values in Table 2-2, labcoats, shoecovers and gloves may be used instead of full PCs.

Appendix 3D

Guidelines for Personnel Contamination Monitoring with Hand-Held Survey Instruments*

General Requirements

1. Verify that the instrument is in service, set to the proper scale and the audio output can be heard during frisking.

2. Hold probe less than 1/2 inch from surface being surveyed for beta and gamma contamination, approximately 1/4 inch for alpha contamination.

3. Move probe slowly over surface, approximately 2 inches per second.

4. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for instrument response.

5. If the count rate increases to a value greater than a preestablished contamination limit or the instrument alarms, remain in the area and notify Radiological Control personnel.

6. The whole body frisk should take at least two to three minutes.

Performance of Monitoring:

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.

CHAPTER 4 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 shall 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 Radioactivity 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 Contamination, High Contamination or Airborne Radioactivity Areas does not require specific labeling or packaging.

3. Radioactive material may be capable of generating a High Radiation Area. These areas shall have special controls in accordance with Article 334.

4. The Radiological Control Organization shall develop response and notification requirements associated with a loss of radioactive material, including searches, internal investigations, documentation and reporting. The Radiological Control Organization shall be notified in the event of a loss of radioactive material.

412 Radioactive Material Labeling

1. Radioactive material outside Contamination, High Contamination or Airborne Radioactivity Areas shall be labeled in accordance with Table 4-1.

Table 4-1 Labeling Requirements for Radioactive Materials

ITEM/MATERIAL	REQUIRED LABELING
Equipment, components and other items that are radioactive, potentially radioactive or have been exposed to radioactive contamination or activation sources	"CAUTION, RADIOACTIVE MATERIAL"
Sealed and unsealed radioactive sources or associated storage containers	"CAUTION, RADIOACTIVE MATERIAL" or standard radiation symbol
Equipment, components and other items with actual or potential internal contamination	"CAUTION, INTERNAL CONTAMINATION" or "CAUTION, POTENTIAL INTERNAL CONTAMINATION"
Components, equipment or other items with fixed contamination	"CAUTION, FIXED CONTAMINATION"

2. The following are not subject to labeling requirements:

   a. Radioactive material surveyed and determined to have contamination levels lower than Table 2-2 values
   b. Radioactive material or containers packaged and labeled for off-site shipment in accordance with Department of Transportation Regulations
   c. Personal Protective Equipment and Clothing
   d. Radiological control samples such as air, process and soil samples or swipes that are in the custody of Radiological Control personnel or personnel properly trained in the handling, packaging and transport of these samples
   e. Equipment or installed system components undergoing maintenance covered by a Radiological Work Permit
   f. Portable tools and equipment with fixed contamination permanently marked with yellow or magenta and maintained in a contaminated tool crib or storage and distribution area

g. Installed system components located within an area, the entrance to which is posted in accordance with Table 2-3
h. Nuclear weapon components
i. Historical items, such as uranium hexafluoride cylinders and large items used in demonstration projects, located within a Radioactive Material Area; such items shall be properly labeled when they are removed from a Radioactive Material Area
j. Short-lived (half-life of 1 hour or less) radioactive material generated during an irradiation (i.e., research samples while an experiment is being conducted, etc.) that is immediately used.

3. Labels shall have a yellow background with a magenta or black standard radiation symbol. Lettering shall be magenta or black. Magenta is the preferred color.

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. Items which are too small to be labeled with all of the stated information should be labeled, at a minimum, with the words "CAUTION RADIOACTIVE MATERIAL" and the standard radiation symbol.

5. Packaged radioactive material should have the label visible through the package or affixed to the outside.

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 shall be securely wrapped in plastic 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. Yellow plastic wrapping material should be used for packaging radioactive material. Yellow plastic sheets or bags should not be used for nonradiological 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.

2. Long-term (more than 60 days) storage of radioactive material should be in a specially designated Radioactive Material Area.

3. Decontamination or disposal of radioactive material is the preferred alternative to long-term storage.

4. Each Radioactive Material Area should be approved by the Radiological Control Manager.

5. A custodian should be assigned responsibility for each Radioactive Material Area. A custodian may have responsibility for more than one storage area.

6. The custodian should conduct walkthroughs of Radioactive Material Areas to check container integrity.

7. 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.

8. Storage of nonradioactive material in a Radioactive Material Area is discouraged.

9. Outdoor storage of radioactive material is discouraged. In cases where outdoor storage is necessary, the integrity of containers used shall be ensured to prevent degradation from weathering and subsequent release of radioactive material. The custodian should check container integrity monthly at outdoor Radioactive Material Areas.

10. Radioactive material should be stored in a manner that reduces combustible loading. The use of cardboard containers for storage is discouraged.

11. Flammable or combustible materials should not be stored adjacent to Radioactive Material Areas.

12. Fire protection measures, such as smoke detectors, water sprinklers and fire extinguishers, should be considered when establishing a Radioactive Material Area.

PART 2 Release and Transportation of Radioactive Material

421 Release to Controlled Areas

1. Radioactive material in Contamination, High Contamination or Airborne Radioactivity Areas shall be surveyed prior to release. Unpackaged radioactive material to be released to Controlled Areas shall be demonstrated to have contamination levels less than Table 2-2 values. Radioactive material to be released to uncontrolled areas shall be surveyed in accordance with Article 422.

2. Material with fixed contamination levels that exceed the total contamination limits specified in Table 2-2, and that have removable contamination less than Table 2-2 levels, may be released for use in controlled areas outside of the radiological areas. These items shall be routinely monitored and controlled in accordance with administrative procedures. Controls shall be established to ensure no unmonitored individual is likely to exceed a dose equivalent that would require monitoring in acordance with Article 511 or 521.

3. Radioactive material with removable contamination levels greater than Table 2-2 values shall be packaged prior to release to Controlled Areas. These items shall be routinely monitored and controlled in accordance with administrative procedures. Controls shall be established to ensure no unmonitored individual is likely to exceed a dose equivalent that would require monitoring in acordance with Article 511 or 521.

4. Material not immediately removed from Contamination, High Contamination, or Airborne Radioactivity Areas after survey shall be controlled to prevent contamination while awaiting release.

5. Records for release of surveyed materials shall describe the property, date of last survey, identity of the person who performed the survey, type and identification number of the survey instruments used, and survey results.

6. Materials released to Controlled Areas shall be labeled in accordance with Article 412.

422 Release to Uncontrolled Areas

1. Material in Controlled Areas or Radioactive Material Areas, documented to have been released from Contamination, High Contamination, or Airborne Radioactivity Areas, shall be surveyed prior to release to uncontrolled areas.

2. DOE 5400.5 describes radiological criteria for releasing material to uncontrolled areas. Material being released shall also be evaluated for internal contamination and contamination under any coatings.

3. DOE 5400.5 describes criteria for releasing radioactive material that has been contaminated in depth or volume, such as activated material or smelted contaminated material.

4. Material not immediately released after survey shall be controlled to prevent contamination while awaiting release.

5. Radiological labeling shall be removed from or defaced on material prior to release for unrestricted use.

423 Transportation 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. The 49 CFR 173 contamination values shall be used as controlling limits for off-site shipments transported by non-DOE conveyances. These limits also apply to on-site transfers of shipments by non-DOE conveyances received from or destined to off-site locations.

2. Table 2-2 removable contamination values shall be used as controlling limits for on-site and off-site transportation when using a DOE conveyance. When a shipment is received from an off-site destination, by a non-DOE conveyance, the 49 CFR contamination values shall be used when transfers are made by a DOE conveyance from the on-site receiving location to the ultimate on-site destination.

3. On-site transfers over nonpublic thoroughfares or between facilities on the same site shall be performed in accordance with written procedures utilizing pre-approved routes. The procedures shall include requirements to ensure appropriate monitoring and control of the radioactive material and should be approved by the Radiological Control Organization.

4. On-site transfers over public thoroughfares shall be performed in accordance with Department of Transportation, state and local shipping requirements and pre-approved agreements.

5. Off-site shipments of radioactive material, including subcontractors' handling of off-site shipments, shall be controlled and conducted in accordance with this Manual and applicable Federal, state and local regulations.

6. 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.

7. Before shipment, and upon receipt of a radioactive shipment, a comparison of package count to the shipping manifest should be made to ensure accountability.

8. Transport conveyances should be visually inspected prior to loading to ensure the trailers are acceptable for the intended use.

9. Transport conveyances should be radiologically surveyed before loading, especially when using commercial carriers specializing in radioactive transport.

10. Transport of large volumes of radioactive material by non-DOE motor vehicles should be "exclusive use" to prevent commingling of DOE and other commercial shipments.

11. The site emergency plan should describe appropriate responses for potential on-site radioactive material transportation accidents.

12. 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.

PART 3 Radioactive Source Controls

431 Radioactive Source Controls

The following provisions apply to sealed and unsealed radioactive sources.

1. DOE N 5400.9 (extended by DOE N 5400.10) describes how sealed radioactive sources shall be controlled and maintained, and specifies requirements for receipt, inventory, storage, transfer, disposal, and integrity testing. Unsealed sources shall be controlled and maintained in a similar manner except for integrity testing.

2. Procurement of radioactive sources shall be coordinated with the Radiological Control Organization.

3. Receipt surveys of radiological material shipments shall be performed by the Radiological Control Organization.

4. Radioactive sources, including radiography sources, shall not be brought on-site by external organizations without the prior written approval of the Radiological Control Organization.

PART 4 Solid Radioactive Waste Management

441 Requirements

1. DOE 5820.2A 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 shall 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 instituted to support waste minimization:

1. Restrict material entering Radiological Buffer Areas to those needed for performance of work.

2. Restrict 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.

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. DOE 5400.3 and 5820.2A describe controls for mixed waste.

2. DOE 5400.3 and 5820.2A, and Article 442, describe how mixed waste generation should be minimized.

3. 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.

4. 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.

5. The most stringent regulatory requirements for the types of waste present should be applied to waste classification and disposal.

PART 5 Control of Radioactive Liquids and Airborne Radioactivity

451 Minimization and Control of Radioactive Liquid Wastes

1. DOE 5820.2A 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 shall be suspended unless sufficient processing, collection and storage capacity is available to accommodate the waste.

4. DOE 5400.5 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 shall 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 nonradioactive liquids.

2. Existing radioactive drains should be evaluated to ensure the following:

   a. Verification of the existing radioactive drain piping configuration
   b. Installation of flow-indicating devices in leak-off lines
   c. Use of plugs to prevent nonradioactive input
   d. Consideration of alternative work controls before systems are drained for maintenance
   e. Controls prohibiting unauthorized use of drains.

3. Modifications to the design or operation of existing radioactive drain systems should be controlled to include:

   a. Design considerations that prevent nonradioactive drain connections into radioactive drains
   b. Procedural and design controls to prevent cross-connections of radioactive drains with nonradioactive systems
   c. Management review of subsequent changes to the design of radioactive drain systems or radioactive drain controls
   d. Management controls to restrict the introduction of hazardous wastes into radioactive drain systems.

453 Control of Airborne Radioactivity

1. Processes and activities with the potential for producing airborne radioactivity shall include engineering controls to limit releases whenever appropriate. The requirements of 40 CFR 61 shall be included in the evaluation.

2. The Radiological Control Organization shall 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 shall be established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

PART 6 Support Activities

461 Personal Protective Equipment and Clothing

1. Protective clothing designated for radiological control use shall be specifically identified by color, symbol or appropriate labeling.

2. Protective clothing designated for radiological control use shall not be used for nonradiological work.

3. Personal Protective Equipment and Clothing shall not be stored with personal street clothing.

4. Cleaned Personal Protective Equipment, such as face shields and respirators, that comes into contact with the wearer's face and company issued non-personal protective clothing shall be surveyed. Contamination levels should be below Table 2-2 total contamination values prior to reuse. 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 cm^2
   b. Alpha radioactivity less than 1,000 dpm/100 cm^2 for transuranics and other alpha emitters in the same Table 2-2 category, and less than 10,000 dpm/100cm^2 for uranium.

6. Sites and facilities are encouraged to:

   a. Apply the latest techniques and instrumentation to detect contamination on Personal Protective Equipment and Clothing below Table 2-2 total contamination values.
   b. Continue efforts to reduce contamination levels on reusable Personal Protective Equipment and Clothing.

462 Laundry

1. Clothing and equipment should be laundered according to facility, color, type and level of contamination.

2. Laundry activities should be performed using processes that 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. Contracting for fully licensed laundry services is encouraged.

6. Cleaned Personal Protective Equipment and laundered protective clothing shall be inspected prior to use. Clothing should be free of tears, separated seams, deterioration and damage, or repaired in a manner that provides the original level of protection.

463 Decontamination

1. Radiological Work Permits or technical work documents shall include provisions to control contamination at the source to minimize the amount of decontamination needed.

2. Work preplanning shall include consideration of the handling, temporary storage and decontamination of materials, tools and equipment.

3. Decontamination activities shall 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. Decontamination methods should be used to reduce the number of contaminated areas.

6. Efforts should be made to reduce the level of contamination and the number and size of contaminated areas that cannot be eliminated.

7. 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) shall be equipped with High-Efficiency Particulate Air (HEPA) filters. If the material to be vacuumed is wet enough to preclude resuspension, then HEPA filters are not necessary.

2. HEPA filters used in vacuum cleaner and portable air-handling equipment shall meet the efficiency and construction requirements for HEPA filters in MIL-F-51068. The maximum flow rate of the device shall not exceed the flow rate at which the HEPA filter was efficiency tested. In addition, the device shall 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. ERDA 76-21, Section 8.3.1, provides additional information on in-place testing of HEPA filters.

3. Vacuum cleaners used for radiological work shall 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 shall be performed periodically for vacuum cleaners in use and labels on these units shall be updated. The frequency of radiation surveys should depend on the specific use of the vacuum cleaner.

5. Airborne radioactivity levels shall be monitored when a vacuum cleaner is used in a highly contaminated area.

6. A nuclear safety review shall be performed and documented prior to the use of a vacuum cleaner for fissile material.

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PART 1 External Dosimetry

511 Requirements

1. Personnel dosimetry shall be required for the following:

   a. Personnel who are expected to receive an annual external whole body dose greater than 100 mrem or an annual dose to the extremities, or organs and other tissues (including lens of the eye and skin) greater than 10 percent of the corresponding limits specified in Table 2-1
   b. Declared pregnant workers who are expected to receive from external sources a dose equivalent of 50 mrem or more to the embryo/fetus during the gestation period
   c. Minors and students, visitors and public expected to receive an annual external whole body dose equivalent of 50 mrem or more in a year.

2. Neutron dosimetry shall be provided when a person is likely to exceed 100 mrem annually from neutrons.

3. Dosimeters shall be issued only to personnel formally instructed in their use and shall 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.

5. Personnel shall 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. Personnel shall wear their primary dosimeters on the chest area, on or between the waist and the neck, in the manner prescribed by dosimetry personnel.

7. Film dosimeters shall not be worn or taken off-site unless specifically authorized by the Radiological Control Manager.

8. The practice at some facilities of taking thermoluminescent dosimeters (TLDs) off-site is discouraged and shall not be implemented where not in place.

9. Personnel shall not wear dosimeters issued by their resident facilities while being monitored by a dosimeter at another facility unless authorized by the Radiological Control Manager. Personnel shall not expose their dosimeters to security x-ray devices, excessive heat, or medical sources of radiation.

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.

512 Technical Requirements for External Dosimetry

1. DOE 5480.15 specifies the requirements for accreditation of personnel external dosimetry monitoring programs by the DOE Laboratory Accreditation Program (DOELAP). A technical basis document shall be developed and maintained for the external dosimetry program. Personnel external dosimeters include but are not limited to TLDs, track etch dosimeters and neutron sensitive film.

2. The technical basis document shall also address dosimeters monitoring radiation outside the scope of DOELAP, such as dosimetry associated with high-energy accelerators and extremity dosimeters.

3. Facilities should participate in intercomparison studies for external dosimetry programs.

4. Personnel exposures to the skin, lens of the eye and extremities shall be reported separately when monitored.

5. Multiple dosimeters should be issued to personnel to assess whole body exposure in non-uniform radiation fields or as required on Radiological Work Permits. Non-uniform radiation fields exist when the dose to a portion of the whole body will exceed the dose to the primary dosimeter by more than 50 percent and the anticipated whole body dose is greater than 100 mrem. The technical basis document should describe the methodology used in determining the dose of record when multiple dosimeters are used.

6. A dose assessment shall be performed for each instance of a lost, damaged or contaminated personnel dosimeter.

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 shall 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 1 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 shall be worn simultaneously with the primary dosimeter and located in accordance with Article 511.6.

3. Supplemental dosimeters shall be read periodically while in use and should not be allowed to exceed 75 percent of full scale.

4. Work authorized by a Radiological Work Permit shall be stopped when supplemental dosimeter readings indicate total exposure or rate of exposure substantially greater than planned. The Radiological Control Organization shall be consulted prior to continuation of work.

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 1 work day are expected. An electronic dosimeter provides an early warning of elevated exposure through the use of alarm set points at specified dose rates or integrated doses.

7. When the dose results from the pocket or electronic dosimeters differ by more than 50 percent from the primary dosimeter result and the primary dosimeter result is greater than 100 mrem, an investigation should be initiated to explain the difference.

514 Area Monitoring Dosimeters

Establishment and maintenance of a comprehensive area monitoring program minimize 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 shall 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 Controlled Areas to supplement existing monitoring programs and to provide data in the event of an emergency.

515 Nuclear Accident Dosimeters

DOE 5480.11 specifies the requirements for a Nuclear Accident Dosimetry Program when sufficient quantities and kinds of fissile material exist to potentially constitute a critical mass as defined in DOE 5480.5 and where exposure of personnel to radiation from a nuclear accident is possible.

PART 2 Internal Dosimetry

521 Requirements

1. The following personnel shall participate in an internal dosimetry program:

   a. Personnel entering Radiological Buffer Areas who have the potential to receive intakes resulting in a committed effective dose equivalent of 100 mrem or more in a year
   b. Declared pregnant workers likely to receive intakes resulting in a dose equivalent to the embryo/fetus of 50 mrem or more during the gestation period
   c. Minors and students, visitors and public likely to receive intakes resulting in a committed effective dose equivalent of 50 mrem or more in a year.

2. The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are:

   a. unavailable
   b. inadequate
   c. internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.

3. Personnel shall participate in followup bioassay monitoring when their routine bioassay results indicate an intake in the current year with a committed effective dose equivalent 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 shall 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 shall be notified promptly of positive bioassay results and the results of dose assessments and subsequent refinements. Dose assessment results shall be provided in terms of rem or mrem.

522 Technical Requirements for Internal Dosimetry

DOE plans to implement accreditation programs for bioassay measurements and internal dose assessment and to provide supplemental technical guidance on the implementation of internal dosimetry programs. Until these accreditation programs are available, this Manual provides the technical guidance to implement the internal dosimetry programs.

1. A technical basis document shall be developed for the internal dosimetry program.

2. Baseline bioassay monitoring of personnel who are likely to receive intakes resulting in a committed effective dose equivalent greater than 100 mrem shall be conducted before they begin work that may expose them to internal radiation exposure.

3. Routine bioassay monitoring methods and frequencies shall be established for personnel who are likely to receive intakes resulting in a committed effective dose equivalent greater than 100 mrem. The technical basis for the methods and frequency of bioassay monitoring should be documented.

4. Management shall require termination bioassay monitoring when a person who participated in the 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.

5. Bioassay analyses shall 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 equivalent
   c. Upon direction of the Radiological Control Organization when an intake is suspected.

6. Levels of intakes that warrant the consideration of medical intervention shall be established for site-specific radionuclides. The effectiveness of medical intervention, such as blocking or chelating agents, shall 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

Interpretations of bioassay results and subsequent dose assessments should include the following:

1. Characteristics of the radionuclide, such as chemical and physical form

2. Bioassay results and the person's previous exposure history

3. Exposure information, such as route of intake and time and duration of exposure

4. Biological models used for dosimetry of radionuclides

5. Models to estimate intake or deposition and to assess dose

6. Intradepartmental coordination between the Radiological Control Organization and the medical organization for doses that may require medical intervention.

PART 3 Respiratory Protection Program

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied air respirators, self-contained breathing apparatus and airline supplied-air suits and hoods.

531 Requirements

1. Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source.

2. DOE 5480.4 mandates the requirements contained in ANSI Z88.2 and 29 CFR 1910.134 for implementation of the Respiratory Protection Program and associated training of personnel.

3. Respirators shall be issued only to personnel who are trained, fitted and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually.

4. Positive controls shall be maintained for the issue, use and return of respirators to ensure that only qualified personnel wear respirators.

5. DOE 5480.4 mandates that breathing air meet the specifications of ANSI/CGA G-7.1 Grade D breathing air as specified in 29 CFR 1910.134. Compressed air supplied to respirators shall be tested quarterly. Compressors shall be of the breathing air type and shall not allow oil or other chemicals and fumes to enter the breathing air supply. Special attention shall be focused on the location of compressor air supply intakes and on cross-connections to other compressed gas systems to prevent contamination.

6. Facility safety analyses should not take credit for the use of respiratory protection for routine work involving potential exposure to airborne radioactive materials. Engineering controls should be designed to control radioactive materials at the source, so that respiratory protection can be reduced.

532 Medical Assessment

Each prospective respirator wearer shall have a medical assessment prior to being fit-tested. The medical assessment shall determine if an employee's medical condition precludes the use of respirators and should follow the guidance in ANSI Z88.6 on frequency and content of the examination. The ability of an employee to accommodate the additional stress placed on the body when working in a respirator is part of this assessment.

533 Use of Respiratory Protection

Personnel using respiratory protection shall:

1. Be issued respirators only upon verification of medical approval, training and fit testing

2. Perform fit checks of their respirators to ensure a proper seal before entering areas requiring respirator use

3. Be clean shaven in the area of fit

4. Use corrective lenses, if needed, that are approved for respirators

5. Be trained to leave the work area when experiencing respirator failure

6. Be trained to remove their respirators to avoid life-threatening situations when exiting an area after respirator failure.

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

The revised 10 CFR Part 20, effective January 1, 1994, states that half-face respirators are "...not satisfactory for use where it might be possible (e.g., if an accident or emergency were to occur) for the ambient airborne concentrations to reach instantaneous values greater than 10 times the...[DAC values]. This type of respirator is not suitable for protection against plutonium or other high-toxicity materials."

1. Half-face respirators shall not be used on a routine basis as a precautionary measure 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. As a result, their permitted protection factor is low.

2. The use of half-face respirators is not prohibited in situations where intakes of radioactive material will be low, such as a few mrem, and where industrial and safety considerations warrant, such as during the operation of heavy equipment.

3. A few DOE facilities use half-face respirators for emergency evacuation purposes. This practice is discouraged and shall not be implemented where not in place.

PART 4 Handling Radiologically Contaminated Personnel

541 Skin Contamination

1. Survey techniques shall be established to determine the extent of skin contamination.

2. When personnel detect skin contamination, they shall notify the Radiological Control Organization.

3. The extent of skin contamination should be determined prior to initiating decontamination procedures.

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 shall be conducted in accordance with Appendix 2C 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
   e. Initiation of appropriate bioassay monitoring
   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 then 2 percent of the Table 2-1 limits. The 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 equivalent 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

6. Evaluate dose prior to permitting the worker to return to radiological work.

PART 5 Radiological Monitoring and Surveys

551 Requirements

1. Radiological monitoring of radiation exposure levels, contamination and airborne radioactivity shall be conducted to characterize workplace conditions, to verify the effectiveness of physical design features and engineering and administrative controls, and to identify areas requiring postings.

2. Monitoring shall be performed only by trained and qualified personnel using instruments that are properly calibrated and routinely tested for operability.

3. Surveys for radiation, contamination and airborne radioactive materials shall be performed as specified in Technical Work Documents and Radiological Work Permits.

4. The Radiological Control Organization shall 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 used to perform radiation surveys shall be readily available and response-checked daily or prior to operation. When response checks are not within ±20 percent of the expected value, the instrument should be taken out of service. When response checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance.

6. Assessment of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries.

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 should be established based on potential radiological conditions, probability of change in conditions and area occupancy factors.

9. Monitoring results should be reviewed by the cognizant radiological supervisor. 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 surveys should be performed in accordance with the following minimum frequencies:

   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 and Radiation Areas
   c. Upon initial entry, weekly during continuing operations, and when levels are expected to change in High Radiation Areas
   d. Weekly, for 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
   g. Monthly, for potentially contaminated ducts, piping and hoses in use outside radiological facilities.

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 shall 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. Where an area radiation monitor is incorporated into a safety interlock system the circuitry shall be such that a failure of the monitor shall either prevent entry into the area or prevent operation of the radiation producing device.

554 Contamination Surveys

1. In addition to the requirements of Article 551, routine contamination surveys should be conducted in Radiological Buffer Areas established for the control of contamination and other areas with the potential for spread of contamination as follows:

   a. Prior to transfer of equipment and material from one Radiological Buffer Area to another
   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

e. Daily, in lunch rooms or eating areas near Radiological Buffer Areas
f. Weekly, in routinely occupied Radiological Buffer Areas
g. Weekly, or upon entry if entries are less frequent, in areas where radioactive materials are handled or stored
h. Weekly, or upon entry if entries are less frequent, where contamination boundaries or postings are located
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
j. After a leak or spill of radioactive materials.

2. Surveys for the release of materials shall be conducted in accordance with Articles 421 and 422.

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 shall 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 5400.5.

6. Swipe surveys for removable contamination shall be reported in units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2). For swipe surveys of small items covering less than 100 cm^2, the results shall be reported in units of dpm per area swiped.

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. Air sampling equipment shall be used in occupied areas where, under normal operating conditions, a person is likely to receive an annual intake of 2 percent or more of the specified Annual Limit of Intake (ALI) values (40 Derived Air Concentration (DAC) hours). An annual intake of 2 percent of a specified ALI generally represents a committed effective dose equivalent to a person of approximately 100 mrem.

3. Continuous air monitoring equipment shall be installed in occupied areas where a person without respiratory protection is likely to be exposed to a concentration of radioactivity in air exceeding 1 DAC or where there is a need to alert potentially exposed workers to unexpected increases in the airborne radioactivity levels. A person exposed continuously to a concentration of radioactivity in air of 1 DAC for 1 work week would generally receives a committed effective dose equivalent of approximately 100 mrem.

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 shall be routinely calibrated and maintained at a frequency of at least once per year. Continuous air monitors should be capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions.

6. Continuous air monitoring equipment required by Article 555.3 shall have alarm capability and sufficient sensitivity to alert personnel that immediate action is necessary in order to minimize or terminate inhalation exposures.

7. The proper operation of continuous air monitoring equipment should be verified daily by performing an operational check. Operational checks should include positive air-flow indication, non-zero response to background activity, and internal check sources or 60 Hz electronic checks when available. Continuous air monitoring equipment should be verified weekly by checking for instrument response with a check source or with ambient levels of radon and thoron daughters.

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.

PART 6 Instrumentation and Calibration

561 Standardization

Standardization on the use of commercially available radiological instrumentation in the DOE is highly encouraged. To assist in the selection of appropriate instrumentation, DOE intends to establish a formal program to evaluate and test each type of radiological instrumentation used throughout the DOE complex.

562 Inspection, Calibration and Performance Tests

1. Radiological instruments shall be used only to measure the radiation for which their calibrations are valid. DOE 5480.4 mandates the requirements contained in ANSI N323 for radiological instrumentation calibration. Calibrations shall use National Institute of Standards and Technology (NIST) traceable sources.

2. Calibration procedures shall be developed for each radiological instrument type and should include frequency of calibration, precalibration requirements, primary calibration requirements, periodic performance test requirements, calibration record requirements and maintenance requirements.

3. Pocket and electronic dosimeters and area radiation monitors should be calibrated at least annually and in accordance with Article 562.1.

4. The effects of environmental conditions, including interfering radiation, on an instrument shall be known prior to use.

5. Functional tests should be used to assess instrumentation designs that include alarms or that involve a process control. A functional test should be developed to test all components involved in an alarm or trip function and performed at least annually.

6. In unusual and limited situations it may be necessary to use an instrument in an application other than that envisioned by the manufacturer. Special calibrations should be performed for use of instrumentation outside manufacturer's specifications. The instrument should be adjusted, calibrated and labeled to identify the special conditions and used only under the special conditions for which it was calibrated.

7. Instruments should bear a label or tag with the date of calibration and date calibration expires.

8. Instruments whose "as found" readings indicate that the instrument may have been used while out of calibration shall be reported to the Radiological Control Organization. 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 undergo calibration prior to use following any preventive or corrective maintenance or any adjustment that voids the previous calibration. A battery change is not normally considered maintenance.

564 Calibration Facilities

1. Calibration facilities should perform inspections, calibrations, performance tests, calibration equipment selection and quality assurance in accordance with the recommendations of ANSI N323 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
   d. Generate records of calibration, functional tests and maintenance in accordance with the referenced standards.

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.

CHAPTER 6 TRAINING AND QUALIFICATION

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PART 6 Training For Special Applications

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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). Training requirements in this chapter apply to personnel entering DOE sites.

612 Standardization

Standardized core courses and training materials shall be used to achieve consistency Department-wide. In establishing local training programs, the standardized core courses shall be presented and site-specific information shall be added. For example, training at accelerator facilities should expand course content for high energy radiation and activation products. Training at plutonium facilities should expand the course content for alpha control. In all cases, the standardized core course materials, as listed in the References section, shall be fully implemented.

Standardized core course training material developed and maintained by DOE Headquarters (EH) consists of lesson plans, designated viewgraphs, student handbooks, qualification standards, question banks and wallet-sized training certificates. The standardized core course training materials were based on ASTM E 1168 87, "Standard Guide for Radiological Protection Training for Nuclear Facility Workers," and were developed using the principles of performance-based training per DOE 5480.20. The standardized core course for the Radiological Control Technicians partially fulfills DOE training accreditation requirements of DOE 5480.18A.

1. Standardized core course training material shall be used for General Employee Radiological Training, Radiological Worker I and II training and Radiological Control Technician training.

2. Wallet-sized training certificates that identify current training status should be provided.

3. Successful completion of the standardized courses for General Employee Radiological Training, Radiological Worker I and II and Radiological Control Technician at one DOE site within the past two years shall be recognized by other DOE sites. Documentation of previous training shall include the individual's name, date of training, topics covered, and name of the certifying official. However, site-specific aspects of the radiological training shall 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 site Radiological Control Manager or a designee shall concur in site-generated radiological training material.

613 Requirements

1. Examinations for General Employee Radiological Training, Radiological Worker I and II training and Radiological Control Technician qualification shall be used to demonstrate satisfactory completion of theoretical and classroom material. 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:

   a. That a minimum passing score be established
   b. That true/false questions not be included
   c. Use of questions randomly selected from the question bank
   d. Acknowledgement 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.

2. Training should address both normal and abnormal situations in radiological control.

3. General Employee Radiological Training shall be completed every 2 years. Changes to the program shall be incorporated as they are identified and a decision made if retraining prior to the 2 year period is needed. In the alternate year when full retraining is not completed, the latest General Employee Radiological Training Handbook (Student Guide) should be distributed for self-study.

4. Radiological Worker I and II retraining shall be completed every 2 years. In the alternate year when retraining is not performed, refresher training shall be completed.

5. Site-specific training and refresher training shall include changes in requirements and updates of lessons learned from operations and maintenance experience and occurrence reporting, for the site and across the DOE complex.

6. 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.

7. Requirements for respiratory protection training are included in Article 531.

8. Training programs developed for radiological control should meet the requirements for performance-based training and, when applicable, training accreditation.

9. 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.

10. Additional requirements for personnel training at Category A reactors are stated in DOE 5480.20.

11. Training records and course documentation shall meet the requirements of Article 725.

614 Qualification Standards for Radiological Control Technicians

1. Qualification Standards define the requirements for demonstrating completion of training. Signatures on the forms in Qualification Standards shall document satisfactory proficiency.

2. Qualification Standards from the standardized core course shall be used.

3. The Qualification Standards from the standardized core course shall be supplemented to include site-specific elements.

4. Qualification Standards for the Radiological Control Technician position shall include on-the-job training to provide hands-on experience directly applicable to the job.

5. On-the-job trainees shall be under the control of qualified personnel. Before performing a job function without direct supervision, a trainee with partially completed qualifications shall have completed the qualifications for that task.

615 Oral Examination Boards

1. An Oral Examination Board shall determine the qualification of candidates for Radiological Control Technician and Supervisor positions. The Oral Examination Board provides an opportunity to identify areas of weakness related to performance of Radiological Control Technician duties and Supervisor functions. The Oral Examination Board also provides the opportunity to identify additional training needs to enhance Radiological Control Technician and Supervisor training programs.

2. The Radiological Control Manager shall designate the Board members and appoint a Chairperson.

3. The Board constituted to evaluate Radiological Control Technician qualification should be composed of at least three persons to include a Radiological Control Technician Supervisor, Radiological Control staff, and line management operations department supervisors and staff personnel, as applicable. Radiological Control 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 are not normally covered in a written examination.

5. The Board constituted to evaluate Radiological Control 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 contractor's site Instructor Qualification Program or possess equivalent qualifications.

2. Instructors should have the technical knowledge, experience and instructional skills required to fulfill their assigned duties.

3. Instructors-in-training shall be monitored by a qualified instructor.

4. Subject matter experts without instructor qualification may provide training in their areas of expertise. However, these subject matter experts should be trained as instructors when this occurs routinely.

PART 2 General Employee Radiological Training

621 Site Personnel

Personnel who may routinely enter the Controlled Area and encounter radiological barriers, postings or radioactive materials shall receive General Employee Radiological Training. This training shall be successfully completed prior to potential occupational radiation exposure. General Employee Radiological Training is recommended for all employees.

1. General Employee Radiological Training shall include the standardized core course training materials.

2. Standardized core General Employee Radiological Training shall 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. If unsuccessful in one attempt, the entire General Employee Radiological Training standardized core training shall be completed. Challenges do not apply to the site-specific portions.

4. Expected time to complete the standardized core and site-specific General Employee Radiological Training is approximately 1 hour.

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 Controlled Areas.

6. Information may be communicated by classroom lecture, videotape, or other applicable methods.

622 Radiological Orientation for Visitors

1. Visitors who enter the Controlled Area shall receive a radiological safety orientation that should include the following topics:

   a. Basic radiation protection concepts
   b. Risk of low-level occupational radiation exposure, including cancer and genetic effects
   c. Risk of prenatal radiation exposure
   d. Radiological protection policies and procedures
   e. Visitor and management responsibilities for radiation safety
   f. Adherence to radiological posting and labeling
   g. Applicable emergency procedures
   h. Training for issuance of dosimeters, where 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 shall 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.

5. Further requirements for Visitors, Tour Groups, Visiting Dignitaries, Scientists and Specialists are addressed in Article 657.

PART 3 Radiological Worker Training

631 Requirements

1. Radiological Worker I training is required for unescorted entry into areas as stated in Table 6-1.

2. Radiological Worker II training is required for unescorted entry into areas as stated in Table 6-1. Additional training is required for special job functions with radiological consequences per article 634.1.

3. 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 shall be completed. Challenges do not apply to the site-specific portions.

4. Radiological Worker I training is not a prerequisite for Radiological Worker II training.

5. 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.

632 Radiological Worker I

1. Workers whose job assignments require access to Radiological Buffer Areas and Radiation Areas shall 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.

2. Radiological Worker I training shall use the DOE standardized core course training materials and in addition shall emphasize site-specific information.

3. Radiological Worker I training, including High/Very High Radiation Area training (Article 632.5), should encompass at a minimum the following site-specific practical factors:

   a. Entering and exiting simulated Radiological Buffer Areas and Radiation Areas (and High/Very High Radiation Areas when such training is included)
   b. Performance of frisking for personnel contamination, as applicable
   c. Verification of instrument response and source check
   d. Anticipated response to alarm situations.

4. Expected time to complete the standardized core course and site-specific Radiological Worker I training is approximately 8 hours. Course length will vary dependent upon the amount of site-specific material.

5. 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 shall 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 632.5. Further, workers who have potential contact with hot particles or use of gloveboxes with high contamination levels shall complete Radiological Worker II training.

1. Radiological Worker II training shall use the standardized core course training materials and in addition shall emphasize site-specific information.

2. Radiological Worker II training shall 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
   f. Performance of frisking for personnel contamination
   g. Verification of instrument response and source check.

3. Expected time to complete the standardized core and site-specific Radiological Worker II training is approximately sixteen hours. Course length will vary dependent upon the amount of site-specific material.

634 Specialized Radiological Worker Training

1. Specialized Radiological Worker training shall be completed for nonroutine 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.

2. Additional training for employees of specialized facilities, such as accelerators and laboratories, will be developed.

Table 6-1 Radiological Worker Entry Training Requirements

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 632.5
***Requires respiratory protection qualification (Article 531)

PART 4 Radiological Control Technician Qualification

641 Requirements

Training and qualification of Radiological Control Technicians and their immediate supervisors shall 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 Radiological Control Technician

1. Radiological Control Technician qualification consists 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.

2. Radiological Control Technician training shall use the standardized core course training materials and in addition should emphasize site-specific information.

3. Radiological Control 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 shall be established to ensure that Radiological Control 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. Radiological Control 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.

643 Continuing Training

1. Following successful completion of standardized core course requirements including practical training, the Radiological Control Technician shall pass both a comprehensive written examination and an Oral Examination Board for final qualification.

2. Following Oral Examination Board qualification, the Radiological Control Technician should begin a 2-year cycle of continuing training required for requalification. Every requalification requires completion of practical training, a comprehensive written examination and a final Oral Examination Board.

3. Continuing Training should provide continued improvement in the knowledge and skills of the Radiological Control 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 shall 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 Radiological Control Technicians satisfy the requirements of Radiological Worker II training.

644 Radiological Control Technician Supervisors

1. Radiological Control Technician Supervisors shall have qualified as Radiological Control Technicians and should participate in continuing radiological training programs.

2. Radiological Control 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. Radiological Control Technician Supervisors shall be requalified every 2 years through comprehensive Oral Examination Boards in accordance with Article 615.

4. Oral Examination Boards should focus on the ability to analyze situations and supervise subordinates. The Radiological Control Technician Supervisor's depth of knowledge should exceed that expected of a Radiological Control Technician.

645 Subcontracted Radiological Control Technicians

1. Subcontracted Radiological Control 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 Radiological Control Technician Supervisor.

2. Subcontracted technicians who work at the facility for extended time periods (more than 6 months) should receive continuing training commensurate with their assigned duties. This should include successful completion of an oral examination.

PART 5 Other Radiological Training

651 Management Training

Line Managers (DOE and contractors) who manage, supervise or provide oversight of Radiological Control Programs shall be trained in the principles of 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, procedure writers) should be trained in the principles of ALARA, basic ALARA techniques and dose reduction techniques. They should also participate in selected portions of job-specific and specialized training, particularly in situations using mock-ups.

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 desirable that planners have Radiological Worker II training.

654 Radiological Control Personnel

1. Radiological Control technical staff and management should have:

   a. A combination of education and experience commensurate with their job responsibilities
   b. Continuing training based on an assessment of job responsibilities to maintain and enhance proficiency
   c. Continuing training to remain cognizant of changes to the facility, operating experience, procedures, regulations and quality assurance requirements.

2. Radiological support personnel may include but are not limited to: dosimetry technicians, instrument technicians, medical personnel, records clerks, whole body counter technicians and laboratory personnel.

3. Radiological support personnel should have:

   a. Applicable training on standardized core course topics from Radiological Worker I and II and Radiological Control Technician training and additional job-specific topics
   b. Training appropriate to the tasks to be performed
   c. Continuing training to provide continued improvement in knowledge and skills.

4. Radiological support personnel who are responsible for implementing the site ALARA program shall receive ALARA training.

5. Certification and involvement with professional industry organizations should be encouraged.

655 Radiographers and Radiation Generating Device Operators

Radiographers shall have training in accordance with 10 CFR 34.31. Radiation Generating Device Operators should have training appropriate for the radiation source involved and commensurate with the level described in 10 CFR 34.31.

656 Emergency Response Personnel

Provisions shall 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.

657 Specialized Visitor Training for Tour Groups and Visiting Dignitaries, Scientists and Specialists

Tour groups and visiting dignitaries, scientists and specialists who enter posted areas other than Controlled Areas should complete the following training:

1. Sites should establish radiological control training for tour groups and visiting dignitaries, scientists and specialists commensurate with the areas they are to enter. This training is intended for individuals not performing hands-on work.

2. Orientation and the use of trained escorts provide an alternative to training with the concurrence of the Radiological Control Manager.

3. Such training should be based on the Radiological Worker standardized core course and site-specific training materials.

4. If visiting scientists or specialists are to do hands-on radiological work while unescorted, consideration should be given to providing full Radiological Worker I or II training. In any event, training should be commensurate with the work to be performed. If limited training is provided for limited tasks, methods should be established to limit the approved work and make other staff members aware of the limitation, such as posting a signed-off training card.

5. Records of this training should be maintained.

PART 6 Training For Special Applications

661 Plutonium Facilities

The following topics should be considered in addition to standardized core training requirements at plutonium facilities:

Properties of plutonium
Special radiological surveys and techniques
External exposure control (neutrons)
Internal exposure control
Containment and glovebox operations and procedures
Special instruments and measurement techniques
Personnel protection
Inventory control and accountability
Criticality safety
Biological effects.

662 Uranium Facilities

The following topics should be considered in addition to standardized core training requirements at uranium facilities:

Properties of uranium
Special radiological surveys and techniques
External exposure control
Toxicological properties and behavior of uranium
Release of uranium-contaminated materials
Instruments and measurement techniques
Personnel protection
Inventory control and accountability
Criticality safety
Biological effects.

663 Tritium Facilities

The following topics should be considered in addition to standardized core training requirements at tritium facilities:

Properties of tritium
Sources of tritium
Exposure pathways and forms of tritium
Exposure control
Tritium containment
Special instruments and measurement techniques
Personnel protection
Inventory control and accountability
Airborne tritium measurement
Airborne tritium controls
Effluent recovery systems
Tritium releases
Bioassay program
Biological effects.

664 Accelerator Facilities

The following topics should be considered in addition to standardized core training requirements at accelerator facilities:

Activation products
Special radiological surveys and techniques
Component source terms
Interlock and warning devices and systems
Access to beam and beam containment
Special instruments and measurement techniques
Biological effects.

CHAPTER 7 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 be maintained as necessary to document compliance with the requirements of 10 CFR 835. 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. Therefore, these records should be high quality, readily retrievable and managed for the prescribed retention period. Consideration should be given to cross-referencing related records to aid retrievability. Records should be handled such that personal privacy is protected.

712 Records Management Program

1. A radiological records management program shall be established. This program shall ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable) and disposition. The records management program should include the following:

   a. Radiological Policy Statements
   b. Radiological Control Procedures
   c. Individual Radiological Doses
   d. Internal and External Dosimetry Policies and Procedures (including Bases Documents)
   e. Personnel Training (course records and individual records)
   f. ALARA Records
   g. Radiological Instrumentation Test, Repair and Calibration Records
   h. Radiological Surveys
   i. Area Monitoring Dosimetry Results
   j. Radiological Work Permits
   k. Radiological Performance Indicators and Assessments
   l. Radiological Safety Analysis and Evaluation Reports
   m. Quality Assurance Records
   n. Radiological Incident and Occurrence Reports (and Critique Reports, if applicable)
   o. Accountability records for sealed radioactive sources
   p. Records for release of material to Controlled Areas
   q. Reports of loss of radioactive material.

2. Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service. Records of results should reside in the custody of the originating contract organization.

3. DOE 1324.2A provides implementing instructions, records inventory requirements, disposition schedules and provisions for the transfer of records.

4. Detailed information concerning an individual's exposure shall be made available to that individual, upon request, consistent with the Privacy Act of 1974, which contains requirements to protect the privacy of individual records.

713 Recordkeeping Standards

1. Radiological control records shall be accurate and legible. The records should include the following:

   a. Identification of the facility, specific location, function and process
   b. Signature or other identifying code of the preparer and date
   c. Legible entries in black ink
   d. Corrections identified by a single line-out, initialed and dated
   e. Supervisory signature to ensure review and proper completion of forms.

2. It is suggested that the Radiological Control Organization maintain a file of names, signatures and initials for future identification of the person who signed or initialed a record.

3. Radiological control records should not include:

   a. Opaque substances for corrections
   b. Shorthand or other nonstandardized terms.

4. Similar procedural standards should be established for computerized records.

PART 2 Employee Records

721 Employment History

Records detailing an employee's preemployment and employment history and the associated radiation dose shall 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

2. Nuclear Regulatory Commission Form 4 or equivalent that documents previous occupational radiation doses

3. Ongoing work history documenting work assignments and radiation doses; the facility and occupational codes defined in DOE 5484.1 should be used for this process

4. When issued, DOE standardized forms to document previous and ongoing radiation doses.

722 Personnel Radiological Records

1. Records of doses received by all individuals for whom individual monitoring was performed shall be maintained. These records shall be sufficient to evaluate compliance with all applicable dose limits and monitoring and reporting requirements.

2. Radiation dose records shall contain information sufficient to identify each person, including social security or employee number.

3. Routine and special records related to radiation doses shall be retained for each person monitored. This shall include records of zero dose. Procedures, data and supporting information needed to reconfirm a person's dose at a later date shall be maintained.

4. External dose records shall include the following:

   a. Applicable extremity, skin, eye and whole body dose results measured with personnel dosimeters, including all multiple dosimeter badging results
   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.

5. Internal dose records shall include the following:

   a. Applicable whole body and lung counting results (including chest wall thickness measurements where applicable)
   b. Applicable urine, fecal and specimen analysis results, including estimated intake and identity of radionuclides
   c. Dose assessment, as required.

6. Records of the summation of external dose and committed dose equivalent to any organ receiving a reportable dose shall be maintained for the individual receiving such dose.

7. The total effective dose equivalent received by each monitored individual shall be maintained for each year the individual is monitored.

8. The dose equivalent to the embryo/fetus of a declared pregnant worker shall be maintained with the occupational exposure records for that worker.

9. Records of lifetime occupational dose, including cumulative total effective dose equivalent since January 1, 1989, should be maintained with the individual's occupational exposure records.

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 shall be retained.

12. Emergency doses and planned special exposures shall be accounted for separately, but maintained with the individual's occupational exposure records.

13. Records of non-uniform dose to the skin caused by contamination on the skin need not be retained in personnel dose records if the dose is less than 2 percent of the limit for the skin in Table 2-1 (see Article 723 for requirements for records of radiological incidents and occurrences).

723 Other Personnel Radiological Records

1. The complete records of radiological incidents and occurrences involving personnel dose shall be retained.

2. Records of employee radiological safety concerns that have been formally investigated and documented should be maintained.

3. Records of the formal written declaration of pregnancy shall be maintained. Records of revocations of such declarations, as well as records indicating that the pregnancy has concluded (therefore, the conditions of Article 215 do not apply), should also be maintained.

724 Medical Records

1. Preemployment 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 nonoccupational radiation doses, such as therapeutic or large amounts of diagnostic radiation doses for medical purposes, is encouraged. Where practical, maintenance of records of preemployment nonoccupational radiation doses is encouraged.

725 Radiological Training and Qualification Records

1. Records of training and qualification in radiological control shall be maintained to demonstrate that a person received appropriate information to perform the work assignment in a safe manner. Qualification standard records shall be retained for on-the-job and practical factor training as well as for formal classroom training.

2. Formal records of training and qualification shall be readily available to first-line supervision and management of involved personnel to aid in making work assignments.

3. Personnel training records shall be controlled and retained. 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
   i. Special instructions to females, their supervisors and coworkers concerning prenatal radiation dose, acknowledged by the worker's signature.

4. Records shall be retained for the following types of training:

   a. General employee radiological training
   b. Radiological Worker training
   c. Periodic retraining
   d. Respiratory protection training
   e. Training of radiological control personnel
   f. Instructor training
   g. Qualifications for special tests or operations
   h. Orientation and training of visitors
   i. Training of emergency response personnel.

5. The following instructional materials shall 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.

6. Documentation of training and qualification received at another DOE location need not be duplicated. Such records should be provided to the person's home office for retention.

PART 3 Visitors

731 Record Requirements

1. Documentation of completion of Radiological Orientation shall be maintained for visitors entering an area where radiation monitoring is required.

2. Records of doses, including zero dose, received by all visitors for whom monitoring was performed shall be maintained. These records shall be sufficient to evaluate compliance with all applicable dose limits and monitoring and reporting requirements.

732 Reports

Monitoring results, including zero dose, should be reported to each visitor monitored in accordance with Articles 511 or 521 within 30 days, and shall be reported no later than 90 days after the end of the visit.

PART 4 Radiological Control Procedures

741 Policies, Procedures and Radiological Work Permits

Records of the Radiological Control Program should consist of policy statements, procedures, Radiological Work Permits and supporting data. The records should be maintained in a chronological sequence 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

Records of As-Low-As-Reasonably-Achievable (ALARA) plans and goals shall be maintained to demonstrate the adequacy of the ALARA Program. These records should include the minutes of ALARA committees and other committees where radiological safety issues are formally discussed.

743 Quality Assurance Records

Records of quality assurance reviews and audits developed for Radiological Control functions shall be retained to ensure that sufficient records are specified, prepared, reviewed, approved and maintained to accurately reflect completed work. DOE 5700.6C provides additional information regarding quality assurance records.

PART 5 Radiological Surveys

751 Requirements

1. 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 shall contain sufficient detail to be meaningful even after the originator is no longer available. Radiological surveys should be recorded on appropriate standard forms and include the following common elements:

   a. Date, time and purpose of the survey

   b. General and specific location of the survey

   c. Name and signature of the surveyor and analyst

   d. Pertinent information needed to interpret the survey results

   5. Reference to a specific Radiological Work Permit if the survey is performed to support the permit.

2. Records shall be maintained to document changes in monitoring equipment, techniques, and procedures.

752 Radiation Surveys

1. In addition to the elements provided in Article 751, records of radiation surveys shall include, at a minimum, the following information:

   a. Instrument model and serial number

   b. Results of the measurements of area dose rates

753 Airborne Radioactivity

1. In addition to the elements provided in Article 751, records of airborne radioactivity shall 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

   d. Air concentrations in general airborne areas and breathing zones

   e. Supporting parameters, including collection efficiency, flow rate, duration of sampling, correction factors and filter medium.

754 Contamination Surveys

1. In addition to the elements required by Article 751, records of contamination surveys shall 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

   d. Follow-up survey results for decontamination processes cross-referenced to the original survey.

PART 6 Instrumentation and Calibration Records

761 Calibration and Operational Checks

1. Calibration records for fixed, portable, and laboratory radiation measuring equipment and individual monitoring devices, shall be maintained and include frequencies, method, dates, personnel, training and traceability of calibration sources to National Institute of Science and Technology or other acceptable standards.

2. Calibration records should be maintained for the following equipment:

   a. Portable survey instruments
   b. Bioassay measurement equipment
   c. Laboratory, counting room and fixed radiation measuring equipment
   d. Process and effluent monitors and sampling equipment
   e. Radiation area monitors
   f. Portal monitors and other personnel contamination monitors
   g. Pocket and electronic dosimeters
   h. Air sampling equipment
   i. Tool and waste monitoring equipment
   j. Protective clothing and equipment monitors.

3. Documentation of instrument operational checks shall be maintained for a period not less than the calibration period of the instrument.

4. Maintenance histories, including the nature of any defects and corrective actions taken, and calibration results for each instrument shall be created and retained.

762 Special Calibration Records

Records of additional tests and checks of instrumentation used in conjunction with a suspected overexposure, questionable indication or unusual occurrence should be retained. In addition, records of special instrument calibrations and modifications made in accordance with Article 562.6 should be retained.

PART 7 Records Management

771 Media

A combination of media may be used for a comprehensive records system. For records that have long-term retention requirements and are stored on media subject to degradation or obsolescence, the records system shall provide for conversion to a more stable medium. All records shall be stored in a manner that ensures their integrity, retrievability and security.

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 be administered:

1. Verification that the resultant copy is legible

2. Confirmation that printed sides are copied

3. Periodic quality audits of the final filmed copy.

773 Computerization of Records

1. Records may be transferred to 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
    h. Assurance that previously stored information is retrievable and useable after system modifications.

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
   d. Quality controls on the copying and imaging processes consistent with Article 772.

774 Retention

1. DOE 1324.2A and 10 CFR 835 describe procedures for retaining records. Upon cessation of activities that could result in the occupational exposure of individuals, all required records shall be transferred to DOE.

2. Once a record has been created, reviewed and signed by appropriate supervision, the record is considered complete and shall 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 1324.2A, should include vaults, file rooms with fixed fire suppression, fire rated cabinets, duplicate storage, or combinations of these.

2. Storage arrangements should address physical damage that could be caused by temperature extremes, moisture, infestation, electromagnetic fields, excessive light, stacking, theft and vandalism.

3. Records should, as a minimum, be protected from:

   a. Exposure to fire, equivalent to an Underwriters Laboratories, Inc., 1.5-hour, or greater, fire resistance rating
   b. Exposure to water damage caused by a 100-year flood
   c. Exposure to windstorm velocities of 100-year recurrence.

PART 8 Radiological Reporting

781 Reports to Individuals

1. Personnel who are monitored by the personnel dosimetry program shall be provided an annual report of their dose. Upon request, an individual shall receive a current radiation dose record.

2. Terminating employees shall be provided a report, within 90 days of the last day of employment, that summarizes radiation dose for the total period of employment at the reporting facility. A written estimate, based upon available information, shall be provided upon termination, if requested.

3. Reports of individual doses shall include the site or facility name, the individual's name and social security or employee number, and all dose information required by Article 722.

4. Reports of individual exposure to radiation or radioactive material required under DOE 5000.3B or as a result of a planned special exposure (10 CFR 835.204(e)) shall be submitted to the Department in accordance with departmental occurrence reporting requirements. Copies of the individual dose information contained in these reports shall be provided to the affected individual at a time not later than transmittal of the report to the Department.

782 Annual Radiation Report

DOE 5484.1 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 visitors.

REFERENCES

The following references contain additional information pertinent to the provisions incorporated in this Manual. Those persons responsible for the Site-Specific Manual should have these references readily available. The citing Article is noted in brackets ([ ]) following each reference. See "Additional References" for addresses of organizations.

FEDERAL

Atomic Energy Act of 1954, as amended. Public Law 83-703. [112.1]

Resource Conservation and Recovery Act of 1976, as amended. Public Law 94-580. [443]

52 FR 1716 "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," signed by President Reagan, January 20, 1987. [213.1]

10 CFR 20 "Standards for Protection Against Radiation." [535]

10 CFR 34 "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations." [365.5]

10 CFR 34.31 "Personal Radiation Safety Requirements for Radiographers and Radiographers Assistants - Training." [655]

10 CFR 835 "Occupational Radiation Protection." [213.3, 223.2, 235.3, Appendix 2A, 774.1, 781.2]

29 CFR 1910.134 "General Industry Standards - Respiratory Protection." [531.2]

49 CFR 172 "Hazardous Materials Tables, Hazardous Materials Communications, Requirements and Emergency Response Information Requirements." [423.1]

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GLOSSARY

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 radioactivity: Radioactive material in any chemical or physical form that is dissolved, mixed, suspended, or otherwise entrained in air.

airborne radioactivity area: Any area where the concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed 10 percent of the derived air concentration (DAC) values. DAC values are contained in Appendices A and C of 10 CFR 835.

annual limit on intake (ALI): 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 equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue.

As Low As Reasonably Achievable (ALARA): An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels 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 that has the objective of attaining doses as far below the applicable controlling limits 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: 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.

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: 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.

calibration: The process of adjusting or determining either:

(1) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or
(2) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.

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 area: Any area where contamination levels are greater than the values specified in Chapter 2, Table 2-2, but less than or equal to 100 times those values.

contamination reduction corridor: A defined pathway though 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 preset 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: Any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive materials. Individuals who enter only the controlled area without entering radiological areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in a year.

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 contaminations; 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: A woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus as provided in Article 215.

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): 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 worker for a working year of 2000 hours (assuming a breathing volume of $2400m^3$). 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 atmospheric cloud. The values are based upon the derived airborne concentration found in Table 1 of the U. S. Environmental Protection Agency's Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, published September 1988.

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 activity: 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.

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

dose: The amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed worker receives. 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 and thereby causing more damage to tissue. The term **dose equivalent**, 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 much energy from alpha radiation, as compared with gamma radiation, to produce this 1 rem **dose equivalent**.

Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

absorbed dose (D): Energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that 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 equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

committed dose equivalent ($H_{T,50}$): The dose equivalent 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 dose equivalent is expressed in units of rem (or sievert).

committed effective dose equivalent ($H_{E,50}$): The sum of the committed dose equivalents to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate weighting factor (w_T) - that is $H_{E,50}=\Sigma w_T H_{T,50}$. Committed effective dose equivalent is expressed in units of rem (or sievert).

cumulative total effective dose equivalent: The sum of the total effective dose equivalents recorded for an individual for each year of employment at a DOE or DOE contractor site or facility, effective January 1, 1989.

deep dose equivalent: The dose equivalent derived from external radiation at a tissue depth of 1 cm in tissue.

dose equivalent (H): The product of the absorbed dose (D) (in rad or gray) in tissue, a quality factor (Q), and all other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

effective dose equivalent (H_E): The summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factors (W_T) - that is ($H_E = \Sigma W_T H_T$). It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert).

external dose or exposure: That portion of the dose equivalent received from radiation sources outside the body (e.g., "external sources").

internal dose or exposure: That portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources").

lens of the eye dose equivalent: The external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.

quality factor: The principal modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor (Q).

shallow dose equivalent: The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

total effective dose equivalent (TEDE): The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). Deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.

weighting factor (w_T): The fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to the affected tissue, H_T, is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue.

whole body: For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.

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.

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, containments, ventilation, filtration or shielding.

entrance or access point: Any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

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 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 cannot be readily removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or laundering.

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 Radiological Control Technician.

general employee: An individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or a visitor who performs work for or in conjunction with DOE or utilizes DOE facilities.

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 phlalate 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: Any area where contamination levels are greater than 100 times the values specified in Chapter 2, Table 2-2, of this Manual.

high radiation area: Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent 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.

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.

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 on contact.

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.

lifetime dose: Total occupational exposure 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.

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: Actions intended to detect and quantify radiological conditions.

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

occupational dose: An individual's dose due to exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational dose does not include planned special exposures, exposure received as a medical patient, background radiation, or voluntary participation in medical research programs.

personnel dosimetry: Devices designed to be worn by a single person for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

personnel monitoring: Systematic and periodic estimate of radiation dose received by personnel during working hours. Also, the monitoring of personnel, their excretions, skin or any part of their clothing to determine the amount of radioactivity 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.

qualification standard: The explicit performance requirements for minimum proficiency in technical, academic, and site-specific knowledge and practical skills used in determining satisfactory completion of training programs. The qualification standard is used to qualify radiological control technicians (RCTs) 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 or 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 manual does not include non-ionizing radiation, such as radio-, or micro-waves, or visible, infrared, or ultraviolet light.

radiation area: Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent 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.

radioactive material: For the purposes of this Manual, radioactive material includes any material, equipment or system component determined to be contaminated or suspected of being contaminated. Radioactive material also includes activated material, sealed and unsealed sources, and material that emits radiation.

radioactive material area: An area or structure where radioactive material is used, handled or stored.

radioactive waste: Solid, liquid or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, and is of negligible economic value considering the cost of recovery.

radioactivity: A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy 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: Any area within a controlled area (but not including the controlled area) which must be posted as required by Chapter 2, Part 3 of this Manual.

radiological buffer area (RBA): A 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: Any work that requires the handling of radioactive material or which requires access to Radiation Areas, High Radiation Areas, Contamination Areas, High Contamination Areas or Airborne Radioactivity Areas.

radiological work permit (RWP): Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The Radiological Work Permit serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions.

radiological workers: General employees who are required to complete Radiological Worker I or II training because their job assignment requires work on, with, or in the proximity of radiation producing machines or radioactive materials. A radiological worker has the potential of being exposed to more than 0.1 rem (1 mSv) per year, which is the sum of the dose equivalent from external irradiation and the committed effective dose equivalent from internal irradiation. A "radiological worker" may also be referred to as a "radiation worker" or a "radworker." Individuals who complete either Radiological Worker I or Radiological Worker II Training are considered radiological workers.

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 5400.5.

rem: Unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution 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 equipment: Equipment used to protect personnel from inhalation of radioactive or hazardous materials.

sievert (Sv): SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality 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.

sealed radioactive source: Radioactive material that is contained in a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to use of the source.

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.

survey: An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

technical work document: A term used to generically identify formally approved documents that direct work, such as procedures, work packages, or job or research plans.

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

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.

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: 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.

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

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

year: The period of time beginning on or near January 1 used to determine compliance with the provisions of this Manual. The starting 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.

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