CHAPTER 3 CONTENTS

TABLES

CHAPTER 3, CONDUCT OF RADIOLOGICAL WORK

Part 1, Planning Radiological Work

Article 311, General

1. Written authorization is required to control access to and work in radiological areas [see 10 CFR 835.501(d)]. The level of detail included in such authorizations depends on facility hazards and the nature of the work force. Technical requirements for the conduct of work including construction, modifications, operations, maintenance, and decommissioning will incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. In general, efforts to reduce the individual dose will not be allowed to cause a concurrent increase in the collective dose.

2. The primary methods used to maintain exposures ALARA shall be facility and equipment physical design features [see 10 CFR 835.1001(a)]. Performance of certain activities such as maintenance and modifications may render permanently installed physical design features inadequate. In such instances, a special subset of design features, often referred to as engineering controls (e.g., temporary shielding, containment devices, and filtered ventilation systems), will be used, as appropriate, to control individual exposures. Design criteria are discussed in Articles 381 and 382.

3. When physical design features, including engineering controls, are impractical or inadequate, the basis should be documented and the work shall be augmented by administrative controls [see 10 CFR 835.1001(a) and (b)]. To accomplish this, the design and planning processes will incorporate radiological control considerations in the early planning stages. The checklist in Appendix 3-A will be used in reducing occupational radiation exposure.

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

Article 312, Planning for Maintenance, Operations, and Modifications

1. Maintenance and modification plans and procedures will be reviewed to identify and incorporate radiological control 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. The radiological hazard assessment and control process will be integrated with the processes used to assess and control other workplace hazards. Requirements and guidance for performing hazards assessments and implementing associated controls are contained in DOE O 440.1A, “Worker Protection Management for DOE Federal and Contractor Employees,” and its associated guidance documents.

3. For routine tasks such as surveillances, tours, and minor nonradiological maintenance, performance of the above review and documentation of identified radiological protection

requirements may be conducted as part of the radiological work permit process (see Article 321) or other work authorization development process that may be required by 10 CFR 835.501(d).

4. ~~The RCM~~This manual establishes trigger levels that require formal radiological review of work activities. The trigger levels are based on radiological conditions in existence or expected prior to implementation of the job-specific engineering and administrative controls.

   The trigger levels for the Site are as follows:

   a. Individual dose exceeding 100 mrem TEDE.

   b. A collective dose of 500 mrem TEDE.

   c. Predicted airborne radioactivity concentrations greater than 1 DAC without respiratory protection and 100 DAC with respiratory protection.

   d. Work area removable contamination greater than 100 times the values shown in Table 2-2.

   e. Entry into areas where whole body dose rates in the work area are greater than 1 rem/hour deep-dose equivalent.

   f. Potential radioactive releases to the environment are greater than or equal to 1 derived concentration guide (DCG). The DCGs are listed in DOE O 5400.5, "Radiation Protection of the Public and the Environment."

5. For nonroutine or complex tasks, a hazards analysis will be conducted using the ISMS and authorization basis process. This review is in addition to the formal radiological review discussed above. An integrated set of controls for all hazards (e.g., radiological, chemical, and physical) will be developed from this hazard analysis.

6. At a minimum, the formal radiological review will 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 mockups 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 the collective dose to be incurred for the job.

o. Provisions for waste minimization and disposal.

7. Radiological control requirements identified as part of the above formal radiological review normally will be documented in the job plans, procedures, or work packages.

8. The appropriate facility/project ALARA committee should review and approve plans for radiological work anticipated to exceed an individual dose of 1 rem TEDE or a collective dose of 5 rem TEDE.

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

Article 313, Infrequent or First-Time Activities

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

1. Formal radiological review in accordance with Article 312.4.

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

3. Review and approval by the facility/project ALARA committee.

4. Enhanced line and Radiological Control organization management oversight during the initiation and conduct of the work.

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

Article 314, Temporary Shielding

1. Temporary shielding is portable shielding used for a limited time, typically less than 1 year, which is not engineered as an integral part of the structure.

2. The installation, use, and removal of temporary shielding will be controlled by procedure.

3. The effects of the additional weight of temporary shielding on systems and components, prior to installation, will be evaluated and established to be within the design basis.
4. Installed temporary shielding will be inspected and surveyed periodically to verify effectiveness and integrity. Installed temporary shielding will be evaluated periodically to assess the need for its removal or replacement with permanent shielding.
5. Radiation surveys will be performed during the alteration or removal of installed temporary shielding.
6. Installed temporary shielding will be visibly marked or labeled with the following or equivalent wording: "Temporary Shielding—Do Not Remove Without Permission from Radiological Control."
7. Specific shielding applications, such as the shielding of low-activity sources or samples, that fall outside the recommendations of this article will be identified in facility/project procedures.
8. The following shielding applications are exempt from the requirements of this article:
    a. Shielding for sources that generate a contact dose rate of less than 5 mrem/hour unshielded.
    b. The marking or labeling of temporary shielding in areas that have not been entered since April 15, 1996, is required during the initial entry. The temporary shielding in those areas will be marked or labeled in accordance with Article 314.6.

Article 315, Technical Work Documents

1. Technical work documents such as procedures, work packages, or job or research plans will be used to control hands-on work with radioactive materials. Requirements for incidental or routine work activities that involve a low potential of worker exposure or workplace contamination, such as the collection of trash or used protective clothing, will be established in generally applicable procedures.
2. Technical work documents used to control radiological work activities will be reviewed and approved by the Radiological Control organization.
3. ~~Radiological control hold points will be incorporated into technical work documents for steps that require action by the Radiological Control organization.~~ The following activities and potential conditions are "significant adverse radiological conditions" and require the use of radiological control hold points in facility/project technical work documents:

~~4.For the Radiological Control organization, routine surveys or low-risk pre-job surveys where no other work control document or outside work group is entering an area, the RWP may invoke the following hold points:~~

    a. When Radiological Control organization actions are required to assess potentially significant changes in radiological conditions and ensure identification of conditions that could require implementation of more stringent controls

(e.g., changing a contamination area to a high contamination area or establishing an airborne radioactivity area).

b. When the potential exists for the whole body dose to exceed 1 rem in 1 hour at 30 cm.

c. When the potential exists in an occupied work areas for airborne radioactivity levels to exceed 10 times the DACs provided in Appendixes A and C of 10 CFR 835.

d. When the potential exists for the unplanned or uncontrolled release of radioactive material greater than 1 DCG to the environment.

~~5.~~4. The radiological control hold point will include the criteria that must be met or action that must be taken to satisfy the hold point prior to continuing or in conjunction with subsequent steps in the planned activity.

Article 316, Control of Internal Exposure

1. The primary methods used to maintain individual internal doses ALARA shall be physical design features such as confinement, ventilation, and remote handling [see 10 CFR 835.1001(a)]. The design objective shall be, under normal conditions, to avoid releases of radioactive material to the workplace atmosphere. The objective, under all conditions, shall be to control inhalation of radioactive material to levels that are ALARA [see 10 CFR 835.1002(c)].

2. Administrative controls, including access restrictions and the use of specific work practices designed to control airborne radioactivity, shall be used as an alternative method to maintain internal doses ALARA if the physical design has been demonstrated and documented to be impracticable [see 10 CFR 835.1001(b)].

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

   a. Entry into airborne radioactivity areas.

   b. During breach of contaminated systems or components.

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

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

4. The selection of respiratory protection equipment will include consideration of worker safety, comfort, and efficiency. The use of positive pressure respiratory protection devices is recommended wherever practicable to alleviate fatigue and increase comfort. See Articles 531 through 535 for additional guidance on respiratory protection.

5. In specific situations, the use of respiratory protection may be inadvisable because of physical limitations or the potential for significantly increased external exposure. In such situations, a formal radiological review will be conducted in accordance with Article 312 to ensure that measures are implemented to assess available options, monitor and reduce worker exposure, and provide for follow-up monitoring, as required. Specific justification to accept the exposure, including a description of measures taken to mitigate the airborne radioactivity, will be documented as part of the review process.
6. The following controls are applicable to activities authorized in accordance with Article 316.5:
    a. Stay-time controls, which control the amount of time a worker can remain in a radiological area, will be established for the entry to limit intake.
    b. Evaluation of workplace airborne radioactivity levels will be provided using real-time (or continuous) air monitors or air samplers with expedited assessment and analysis of results.
7. Any person with an open, unprotected wound (a wound not properly bandaged and protected with personal protective equipment) should not work in areas where radioactive contamination is possible and should not directly handle radioactive material or material suspected of being radioactively contaminated. Employees working in such areas should report the presence of open wounds to their managers. If an employee sustains a wound while in such an area or during handling of radioactive material, the employee should report immediately to Radiological Control personnel.
8. Wounds must be assessed through the Site Occupational Medical Program. The Radiological Control organization, assisted by the Occupational Medical Program, will determine whether the wound represents a significant risk for internal contamination if properly bandaged and wearing the appropriate personal protective equipment. If the assessment indicates that the risk is negligible, then work may be performed in areas where radioactive contamination is possible.

Part 2, Work Preparation

Article 321, Radiological Work Permits

Radiological work permits (RWPs) are used at facilities or by projects to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities.

1. The following information is included in RWPs:
    a. Description of the work involved.
    b. Work-area radiological conditions.
    c. Dosimetry requirements.
    d. Pre-job briefing requirements, as applicable.

e. Training requirements for entry.

f. Protective clothing and respiratory protection requirements.

g. Radiological Control coverage requirements and stay-time controls, as applicable.

h. Radiological control hold points.

i. Limiting radiological conditions that may void the RWP.

j. Special dose or contamination reduction considerations.

k. Special personnel frisking considerations.

l. Technical work document number, as applicable.

m. Unique identifying number.

n. Date of issue and expiration.

o. Authorizing signatures.

2. All RWPs should be integrated with other work authorizations that address safety and health issues such as those for industrial safety and hygiene, welding, or confined space entry.

3. If necessary to ensure appropriate accounting, RWP numbers will be used in conjunction with the Radiological Control Information Management System to relate the individual or collective dose to specific activities.

Article 322, Use of Radiological Work Permits

Facilities and projects use two different types of RWPs. General RWPs are used for entry and repetitive work in areas with known and stable low-hazard radiological conditions. Job-specific RWPs are used for work that is more complex and for entry into higher-hazard areas.

1. General or job-specific RWPs will be used to control the following activities:

   a. Entry into radiation areas, high radiation areas, very high radiation areas, contamination areas, high contamination areas, and airborne radioactivity areas.

   b. Handling of materials with removable contamination that exceeds the values of Table 2-2.

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

   d. Work that disturbs the soil in soil contamination areas.

   e. Work that involves digging in underground radioactive material areas.

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

3. General RWPs may be used to control routine or repetitive activities such as tours and inspections or minor work activities in areas with well-characterized and stable radiological conditions. General RWPs will not be approved for periods longer than 1 year.
4. Radiological surveys will be routinely reviewed to evaluate the adequacy of RWP requirements. An RWP will be updated if radiological conditions change to the extent that the protective requirements must be modified.
5. All RWPs will be posted at the access point to the applicable radiological work area or otherwise made available at the work location. The Site normally uses the Radiological Control Information Management System access control station as an access point because all personnel must sign in at this point and acknowledge the RWP requirements and conditions.
6. Workers will acknowledge by signature, or through electronic means where automated access systems are in place, that they have read, understand, and will comply with applicable RWPs prior to initial entry to the area and after any revisions to the RWP.
7. Worker pocket or electronic dosimeter readings will be recorded in a format that identifies and provides linkage to an applicable RWP.
8. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in this article and Articles 321 and 323.

Article 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 an area should initiate the preparation of an RWP.
2. The RWP will be based on current radiological surveys and anticipated radiological conditions.
3. The RWP, including any revisions or extensions, will be approved by the supervisor responsible for the work or area and the appropriate Radiological Control management. The RWP review requirements are as follows:
    a. **Radiological Control management**: Performs an independent review of the RWP and approves the RWP, acknowledging that all radiological controls for the work to be performed are included.
    b. **Job controller or supervisor**: Reviews and approves the RWP, acknowledging acceptance of responsibility for the radiological work practices exercised by the radiological workers performing the work.
    c. **Facility/project management**: Reviews and approves the RWP. The manager is responsible for the facility or area and recognizes facility evolutions that may result in changed radiological conditions affected by or affecting this RWP.

d. **Facility/project management or Radiological Control management**: Assigns other reviews, as deemed necessary, to review the RWP for completeness and compliance to current requirements.

Article 324, Pre-Job Briefings

1. At a minimum, pre-job briefings will be held prior to the conduct of work anticipated to exceed the trigger levels identified in Article 312.4.
2. At a minimum, the pre-job briefing will 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 will be conducted by the cognizant work supervisor or other individuals most familiar with the work to be performed and the required controls.
4. Workers and supervisors directly participating in the job, cognizant Radiological Control personnel, and representatives from involved support organizations should attend the briefing.
5. Records of actions taken to maintain doses ALARA shall be maintained; therefore, if pre-job briefings are used for ALARA purposes, records of the briefings shall be maintained [see 10 CFR 835.704(b)]. A summary of topics discussed and attendance at the pre-job briefing should be documented. This documentation will be maintained with the technical work documents.

Article 325, Use of Personal Protective Equipment and Clothing

1. Individuals shall wear protective clothing during work in contamination and high contamination areas [see 10 CFR 835.1102(e)] and should wear protective clothing during the following activities:
   a. Handling of contaminated materials with removable contamination in excess of Table 2-2 levels.
   b. Work in airborne radioactivity areas.
   c. As directed by the Radiological Control organization, or as required by the RWP or other work authorization.

2. Protective clothing and shoes designated for radiological control will be:
   a. Marked in accordance with Article 461.
   b. Used only for radiological control purposes.
3. Protective clothing dress-out areas will be established directly adjacent to the work area, where possible. In cases where dress-out areas cannot be established directly adjacent, they will be located as close as practical to provide easy access to the work area and sufficient space for dress out. Workers will proceed directly to the radiological work area after donning personal protective equipment and clothing.
4. General guidelines for protective clothing selection and use are provided in Table 3-1 and Appendix 3B, which also specifies the procedure for doffing potentially contaminated fire-fighting clothing.
5. The use of lab coats as radiological protective clothing is appropriate for limited applications, such as those discussed in Appendix 3B where the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Lab coats should not be used as protective clothing for performing physical work activities in contamination, high contamination, or airborne radioactivity areas.
6. Appropriate instructions for donning and removing protective clothing should be posted at the dress-out areas and step-off pads for the affected work areas.

Table 3-1. Guidelines for selecting protective clothing.

	Removable Contamination Levels		
	Low (1 to 10 times Table 2-2 values)	Moderate (10 to 100 times Table 2-2 values)	High (>100 times Table 2-2 values)
Work Activity	Recommended Protective Clothing		
Routine work	Full set of protective clothing	Full set of protective clothing	Full set of protective clothing, double gloves and double shoe covers
Heavy work	Full set of protective clothing and work gloves	Double set of protective clothing and work gloves	Double set of protective clothing and work gloves
Work with pressurized or large volume liquids, closed system breach	Full set of nonpermeable protective clothing	Double set of protective clothing (outer set nonpermeable) and rubber boots	Double set of protective clothing, nonpermeable outer clothing, and 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, lab coats, shoe covers, and gloves may be used instead of full protective clothing.

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

8. For radiological control purposes, company-issued clothing that is not specifically intended to protect individuals from contamination hazards, such as modesty clothing, work coveralls, and shoes, are considered the same as personal clothing.

Part 3, Entry and Exit Provisions

Article 331, Controlled Areas

The facility/project Radiological Control manager's approval is required prior to each radiologically controlled area access by untrained employees or visitors. Equivalent controls are provided through the assignment of a fully knowledgeable and briefed escort. The work may include one-time inspections, testing, management oversight, tours, engineering reviews, and other nonroutine activities.

1. All radiological workers shall complete radiation safety training commensurate with the hazards and required controls, as follows:

   a. Prior to unescorted access to controlled areas [see 10 CFR 835.901(a)].

   b. Prior to receiving an occupational dose during access to controlled areas [see 10 CFR 835.901(a)].

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

3. Radiological Control special instruction signs may be posted to inform personnel "Do not loiter" in designated controlled areas to maintain exposures ALARA.

Article 332, Radiological Buffer Areas

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

   a. Completion of training in accordance with Table 3-2.

   b. Use of a TLD (unless otherwise stated TLD is the primary dosimeter), as appropriate.

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

Table 3-2. Radiological Control training guidelines.

Activities	Minimum Training	RCM Article Citation
Entry as a member of the public[a]	Orientation	622
Unescorted entry into controlled areas and radioactive material areas or underground radioactive material areas where an individual is not likely to receive ≥ 0.1 rem in 1 year Unescorted entry into radiological buffer areas[b]	General Employee Radiological Training	612, 613, and 621
Unescorted entry into radiological buffer areas Unescorted entry into radioactive material areas or underground radioactive material areas (> 0.1 rem in 1 year) Unescorted entry into soil contamination areas for work that does not disturb the soil Unescorted entry into radiation ~~or high radiation~~ areas	Radiological Worker I	612, 613, 631, and 632
Unescorted entry into high, locked high, or very high radiation areas	Radiological Worker II, or Radiological Worker I with high radiation option (see Article 632.3)	612, 613, 631, 632, and 633
Completion of specialized training developed as a requirement to work with radioactive materials incident to specialized tasks or where job-specific training provides equipment knowledge and controls	Radiological Worker II for Laboratory Personnel Radiological Worker II for Fire Fighters	612, 613, 631, 632, and 634
Unescorted entry into contaminated areas[c] Unescorted entry into soil contamination areas to perform work that disturbs the soil Use of containment devices with high contamination levels[d]	Radiological Worker II	612, 613, 631, and 633

RCM = Radiological Control Manual
a. The facility Radiological Control manager may authorize exceptions to the escort requirements in accordance with Article 622.
b. Unescorted entry requires completion of training and practical demonstration of conducting a proper self-survey with beta-, gamma-, and alpha-contamination monitoring instrumentation.
c. Contaminated areas include contamination, high contamination, and airborne radioactivity areas.
d. The devices include gloveboxes and other containment devices with surface contamination levels exceeding 100 times Table 2-2 values.

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

Minimum requirements for unescorted entry into radioactive material areas, soil contamination areas, and underground radioactive material areas include completion of training in accordance with Table 3-2. If individual doses are likely to exceed the applicable monitoring thresholds, individual monitoring shall be conducted in accordance with Articles 511 and Article 521 [see 10 CFR 835.402(a) and (c)].

Article 334, Radiation, High Radiation, Locked High Radiation, and Very High Radiation Areas

1. Minimum requirements for unescorted entry into radiation areas shall include completion of radiation safety training [see 10 CFR 835.901(b)] and will include the following:
   a. Completion of training in accordance with Table 3-2.
   b. Providing the worker's signature on the RWP.
   c. Use of a ~~primary dosimeter (~~TLD~~)~~.
2. Physical controls to prevent inadvertent or unauthorized access to high and very high radiation areas are established in Appendix 3-C.
3. Minimum requirements for unescorted entry into high radiation areas shall include completion of radiation safety training [see 10 CFR 835.901(b)], use of a ~~primary dosimeter (~~TLD~~)~~ [see 10 CFR 835.402(a)(5)], radiation monitoring during access, and use of supplemental alarming dosimeter [see 10 CFR 835.502(a)], and will include the following:
   a. Completion of training in accordance with Table 3-2.
   b. Providing the worker's signature on the RWP.
4. Minimum requirements for unescorted entry into a locked high radiation area~~s~~ (LHRA), where individual worker dose rates could exceed a whole body dose of 1 rem in 1 hour, shall include completion of radiation safety training [see 10 CFR 835.901(b)], use of a ~~primary dosimeter (~~TLD~~)~~ [see 10 CFR 835.402(a)(5)], radiation monitoring during access, and use of supplemental alarming dosimeter [see 10 CFR 835.502(a)], and will include the following:
   a. Completion of training in accordance with Table 3-2.
   b. Providing the worker's signature on the RWP.
   c. Determination of the individual current dose, based on primary and supplemental dosimeter readings.
   d. Completion of the pre-job briefing, as applicable.
   e. RCT coverage as determined by the Radiological Control organization.
5. Individuals shall be prevented from unauthorized or inadvertent entry to very high radiation areas [see 10 CFR 835.502(c)].

6. In addition to the controls required in Articles 334.2 and 334.3 when using a radiation generating device, a radiation survey will be performed prior to the first entry to the area after the radiation source has been secured or shielded to verify the termination of the very high radiation field.
7. Operations personnel will immediately notify the Radiological Control organization of operational or system changes that could result in significant changes in radiological hazards. Such notifications will facilitate Radiological Control organization actions to erect postings and implement required entry controls.
8. The number, issue, and use of keys will be strictly controlled where locked entryways are used to control access to high, locked high, and very high radiation areas.
9. The Radiological Control organization will maintain a list of high, locked high, and very high radiation areas.
10. Written procedures will be implemented to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Determination of the effectiveness of these control devices also should consider individual training and response. Annual inspections of the physical access controls to high, locked high, and very high radiation areas will be performed to verify that controls are adequate to prevent unauthorized entry.

Article 335, Contamination, High Contamination, and Airborne Radioactivity Areas

1. Minimum requirements for unescorted entry into contamination areas shall include completion of radiation safety training [see 10 CFR 835.901(b)] and protective clothing as specified on the RWP [see 10 CFR 835.1102(e)] and will include the following:
   a. Completion of training in accordance with Table 3-2.
   b. Providing the worker's signature on the RWP.
   c. Use of primary dosimetry (TLD), as appropriate.
2. Minimum requirements for unescorted entry into high contamination or airborne radioactivity areas shall include completion of radiation safety training [see 10 CFR 835.901(b)] and protective clothing as specified on the RWP [see 10 CFR 835.1102(e)] and will include the following:
   a. Completion of training in accordance with Table 3-2.
   b. Providing the worker's signature on the RWP.
   c. Use of respiratory protection when specified by the RWP or other written authorization.
   d. Completion of pre-job briefing for high contamination or airborne radioactivity areas, as applicable.
   e. Use of primary dosimetry (TLD), as appropriate.

3. Individuals exiting contamination, high contamination, or airborne radioactivity areas will remove protective clothing (see Appendix 3B for recommended procedure). When entering an uncontaminated area, these individuals shall be monitored, as appropriate, for the presence of contamination on their skin and clothing [see 10 CFR 835.1102(d)]. These individuals will 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 be equipped with the following:
   a. Step-off pads located outside the exit point, contiguous with the area boundary.
   b. Step-off pads maintained free of radioactive contamination.
   c. Designated containers inside the area boundary for the collection of protective clothing and equipment.
   d. Contamination monitoring equipment located as close to the step-off pad as background radiation levels permit.
5. Multiple step-off pads should be used at exits from high contamination areas. The use of multiple step-off pads is described in Appendix 3B. When the egress is from a high contamination area to a contamination area, one step-off pad is used as described in Appendix 3B.
6. Protective clothing and monitoring provisions specific to benchtop work, laboratory fume hoods, sample stations, and gloveboxes are identified in Article 347.
7. Article 421 provides requirements and guidance for removing materials and equipment from benchtop work areas, laboratory fume hoods, sample stations, and glove boxes or for retention in the contaminated tool crib in accordance with Article 442.5.

Article 336, Member of the Public Entry Provisions

1. Site procedures will identify area entry requirements and access restrictions for members of the public.
2. Members of the public with a demonstrated need to enter the following areas may be allowed access if such access is controlled with a combination of orientation and the use of escorts trained for the specific area:
   a. Radiological buffer areas.
   b. Radiation areas.
   c. Contamination areas.
   d. Radioactive material areas.
   e. Soil contamination areas.
   f. Underground radioactive material areas.
3. Members of the public will be prohibited from entering high radiation, very high radiation, high contamination, and airborne radioactivity areas.

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

Article 337, Controlling the Spread of Contamination

The Site contractor policy is to control contamination at its source. Controls shall be implemented as necessary to prevent the spread of removable contamination outside of radiological areas under normal operating conditions [see 10 CFR 835.1102(a)]. The extent of these controls depends on the type and level of contamination present and the activities in and around the area. The following measures should be practiced to prevent the spread of contamination across the boundaries of contamination, high contamination, and airborne radioactivity areas:

1. Use solid barriers to enclose areas wherever practicable.
2. Mark and secure items such as hoses and cords that cross the boundary to prevent safety hazards and the spread of contamination. Markings may include radiological hazard warning labels, ribbon, or tape.
3. Control and direct airflow from areas of lesser to greater removable contamination or airborne radioactivity.
4. Use engineering controls and containment devices such as glovebags, gloveboxes, and tents.

Article 338, Monitoring for Personnel Contamination

1. Individuals shall be monitored as appropriate for the presence of surface contamination when exiting contamination, high contamination, and airborne radioactivity areas [see 10 CFR 835.1102(d)]. Individuals should perform a whole body frisk immediately upon entry into an uncontaminated area after exiting contamination, high contamination, or airborne radioactivity areas, or as directed by the Radiological Control organization or the RWP.
2. In addition to the above, individuals exiting a radiological buffer area containing contamination, high contamination, or airborne radioactivity areas should, at a minimum, perform a hand and foot frisk. This frisk is optional if the radiological buffer area exit is immediately adjacent to the location where the exiting individual already has performed a whole body frisk.
3. Where frisking cannot be performed at the exit from contamination, high contamination, or airborne radioactivity areas because of high background radiation levels, individuals will:
    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 will be performed after removal of protective clothing and prior to washing or showering.
5. Guidelines for personnel frisking are provided in Appendix 3D.

6. Personal items such as notebooks, papers and flashlights are subject to the same frisking requirements as the person carrying them and may be frisked by the individual carrying them, provided the individual has been trained to perform this function.
7. Instructions for personnel frisking should be posted adjacent to personnel frisking instruments or personnel contamination monitors.
8. The personnel frisking provisions in this article are not applicable at those facilities that contain only radionuclides such as tritium that cannot be detected by currently available hand-held or automated frisking instrumentation. At such facilities, additional emphasis should be placed on bioassay programs and routine area contamination survey and air sampling programs.

Part 4, Radiological Work Controls

Article 341, General

1. Radiological work activities shall be conducted as specified by the controlling written authorization [see 10 CFR 835.501(d)].
2. Prerequisite conditions such as tag-outs and system isolation will be verified in accordance with the technical work documents before work is initiated.

Article 342, Work Conduct and Practices

1. Contamination levels caused by ongoing work will be monitored and maintained ALARA. When contamination levels exceed the values shown in Table 2-2 and reach posting requirements for a high contamination area, or when high contamination levels double, and these conditions were not anticipated in the original work planning, work must be stopped and reassessed by the Radiological Control organization and job supervisor. The area must be decontaminated to a lower level or additional restrictions must be applied before work may continue.
2. Tools and equipment will 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 will 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 will be wrapped or sleeved to minimize contamination.
4. Engineering controls such as containment devices, portable or auxiliary ventilation, and temporary shielding will be installed in accordance with technical work documents and inspected prior to use.
5. The identity of components and systems will be verified prior to work.
6. Work activities and shift changes will be scheduled to prevent idle time in radiological areas.

7. Where practicable, parts and components will be removed from areas with higher radiological hazards to areas with lower radiological hazards to perform work.

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

9. Requirements for area cleanup normally will be included in technical work documents. Work activities will not be considered complete until support material and equipment have been removed and the area has been returned to at least pre-work status.

10. To minimize intakes of radioactive material, smoking, eating, drinking, or chewing will not be permitted in radiological buffer areas, contamination, high contamination, or airborne radioactivity areas. If the potential for personnel heat stress exists, drinking may be permitted within a contamination area when the following criteria are met:

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

    b. All drinking is from approved containers or sources.

    c. An RCT monitors workers' hands and faces for contamination prior to drinking.

    d. Participating workers are monitored as part of the bioassay program.

    e. Applicable requirements and controls are described in approved procedures.

Article 343, Logs and Communications

1. Radiological Control personnel will 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 will review logs and receive a turnover briefing from the personnel they are relieving.

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

4. Workers will keep Radiological Control personnel informed of the status of work activities that affect radiological conditions.

Article 344, Review of Work in Progress

1. As part of their normal work review, both Radiological Control personnel and work supervisors should periodically review and provide oversight for ongoing jobs to ensure that prescribed radiological controls are being implemented.

2. Radiological Control personnel should conduct frequent tours of the workplace to provide oversight of 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 will be reviewed to identify causes and assess the need for corrective actions.

Article 345, Stop Radiological Work Authority

1. For any of the following reasons, RCTs and their supervisors, line supervision, and any worker shall have the authority and responsibility to stop radiological work activities [see DOE O 440.1A(g)]:

   a. Inadequate radiological controls.

   b. Radiological controls not being implemented.

   c. A radiological control hold point not being satisfied.

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

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

4. Resumption of work involving radiological hazards will require the approval of the concerned employee, the line manager responsible for the work, and the Radiological Control director or designee.

Article 346, Response to Abnormal Situations

1. ~~The RCM~~This manual and specific facility/project procedures for responding to abnormal situations establish requirements for alarm response. Facility/project alarm response procedures will 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 will include the following actions:

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

   b. All individuals 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, will include the following actions:

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

   b. Alert others.

c. All affected individuals exit the area.

d. Notify Radiological Control personnel.

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

   a. Remain in the immediate area.

   b. Notify Radiological Control personnel.

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

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

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

   a. Stop or secure the operation causing the spill.

   b. Warn others in the area.

   c. Isolate the spill area if possible.

   d. Minimize individual exposure and contamination.

   e. Secure unfiltered ventilation.

   f. Notify Radiological Control personnel.

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

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

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

1. Provisions for RWPs are provided in Article 322.
2. Protective clothing should include, at a minimum, lab coats and gloves. Gloves should be secured at the wrist as necessary.
3. Shoe covers should be considered based on the potential for floor contamination.
4. Workers should monitor their hands periodically during work as appropriate with the work controls.

5. Upon completion of work or prior to leaving the area, workers shall monitor those areas of their bodies that are potentially contaminated [see 10 CFR 835.1102(d)]. At a minimum, this includes hands, arms, and front portions of the body. A whole-body frisk is recommended.
6. If the potential exists for splashing or airborne radioactivity, such as when taking pressurized samples, additional controls such as rubber aprons, face shields, full protective clothing, or respiratory protection should be instituted.
7. Gloveboxes should be inspected for integrity and operability prior to use.
8. Gloveboxes should be marked with, or survey measurements should be posted to identify, whole-body and extremity dose rates.

Article 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. A hot particle is defined as a particle, with an area smaller than 1 cm^2, causing a count rate greater than 6,000 counts per minute on a Geiger-Mueller pancake probe, which will in most cases generate a skin dose rate of greater than 100 mrem in 1 hour.
2. Measures for controlling hot particles, as identified in Items 3 through 7 of this article, will 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. Survey provisions for areas or operations with the potential for hot-particle contamination are established in Article 554.9.
4. Contamination area postings will be annotated to specifically identify the presence of hot particles and posting may specify controls.
5. Access to hot-particle contamination areas normally will be controlled by a job-specific RWP. The following controls will be considered for inclusion in the RWP:
   a. Periodic personnel monitoring during the work activity, at a frequency based on the potential magnitude of personnel exposure.
   b. Additional personal protective equipment and clothing.
   c. Direct radiological control coverage during work and assistance during protective clothing removal.
   d. Use of sticky pads or multiple step-off pads.

6. Response to hot-particle skin or clothing contamination should include the following:
   a. Immediate removal and retention of the hot particle for subsequent analysis.
   b. Analysis of the particle.
   c. Assessment of worker dose.
   d. Evaluation of work-control adequacy.

Part 5, Evaluation of Performance

During the conduct of radiological work and the handling of radioactive materials, abnormal events may occur that 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 a recurrence. In addition, successful performance or completion of unique activities will 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.

Article 351, Conduct of Critiques

1. Critiques are meetings of the individuals knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts. The purpose of the critique is not to assign blame, but to establish and record the facts.
2. Critiques will be conducted for successes and abnormal events.
3. Critique leaders will be trained in the required elements of the critique process and the appropriate methods of conducting and controlling the critique.
4. 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.
5. At a minimum, the general critique process should include the following elements:
   a. Formal meetings, chaired by a critique leader.
   b. Attendance by all members of the work force who can contribute.
   c. Personal statement forms completed by selected personnel before the meeting.
   d. Attendance records.
   e. Recorded minutes signed by the critique leader and all contributors.
   f. Pertinent personal statements that are signed and attached to the meeting minutes from individuals involved in the event.
   g. A listing of the facts in chronological order.
   h. Supporting materials including documents, records, photographs, parts, and logs maintained by the critique leader.

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

Article 352, Post-Job Reviews

1. A post-job review is required for any job that exceeds the ALARA committee trigger level in Article 312.8, and is conducted in conjunction with the facility/project work activities.
2. As appropriate to the work in question, post-job reviews should include evaluation of:
   a. Total and individual doses compared to pre-job estimates.
   b. Efficacy of the radiological controls implemented for the work.
   c. Any adverse events occurring during the work such as skin contamination, unexpectedly high individual exposures, or problems resulting from unnecessarily burdensome control requirements.
   d. Conflicts between radiological safety requirements and other safety requirements.
   e. Opportunities to improve performance or efficiency during repeated or similar work.
   f. Significant differences between expected and actual radiological conditions or other issues affecting the work.
   g. Worker feedback for possible improvements in radiological safety practices for repeated or similar work.

Article 353, Lessons Learned

The ~~Site contractor~~ Lessons Learned Program compiles and distributes lessons learned reports of past radiological events at the Site and at other facilities. The Radiological Control organization, in conjunction with line management and training, should evaluate the Lessons Learned Program lessons learned reports and incorporate the applicable issues into the radiation protection program, the Radiological Control training program, and related operations.

Part 6, Special Applications

Article 361, Plutonium Operations

Exposure to small quantities of plutonium is perceived as presenting 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 [see 10 CFR 835.1001(a)].
2. In addition to the provisions in ~~the RCM~~this manual, guidance contained in DOE-STD-1128-98, “Guide of Good Practices for Occupational Radiation Protection in Plutonium Facilities,” should be used in plutonium operations. The standard provides specific guidance related to dosimetry, radiological monitoring, instrumentation, contamination control, and applicable radiological control procedures.

Article 362, Uranium Operations

The health risk of uranium is unusual in that its chemical toxicity is more harmful in the human body than its radioactivity on a unit mass basis. In addition, processed uranium sometimes contains transuranic and other radionuclides from recycled materials. For these reasons, in addition to provisions throughout ~~the RCM~~this manual, the guidance contained in DOE-STD-1136-2000 should be used for uranium operations. Specific guidance is provided in DOE-STD-1136-2000 for management controls, radiological monitoring, contamination control, and internal and external exposure controls.

Article 363, Tritium Operations

The following characteristics of tritium require consideration in the implementation of the radiation protection program at tritium facilities:

1. Tritium emits low-energy beta particles that cannot be monitored using external dosimeters, consequently the use of bioassay measurements is required 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. Because of its ability to permeate substances that it contacts, including human skin, tritium is difficult to contain. Special attention will be directed to the selection of personal protective equipment and clothing.
5. For the above reasons, guidance contained in DOE-HDBK-1079-94, “Primer on Tritium Safe Handling Practices,” and DOE-HDBK-1129-99, “Tritium Handling and Safe Storage,” should be used in tritium operations. These handbooks provide specific guidance related to internal dosimetry, contamination and air monitoring, tritium containment practices and techniques, and personal protective equipment and clothing selection.

Article 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 in this ~~RCM,~~manual, guidance contained in Stanford Linear Accelerator Center *Health Physics Manual of Good Practices for Accelerator Facilities* (Casey et al. 1988) should be used in accelerator operations. The Stanford manual provides specific guidance related to radiological monitoring, dosimetry, shielding design, use of interlocks, and procedures and other administrative controls.

2. Consideration also should be given to the information provided in DOE O 420.2A, "Safety of Accelerator Facilities."

3. Safety devices and interlocks that are necessary to meet the high radiation area control requirements of 10 CFR 835.501 shall be operational prior to and during operation of an ionizing radiation beam [see 10 CFR 835.502(b)]. Operational status will be verified by testing. Safety devices and interlocks will be fail-safe.

Article 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. Facility/project procedures will contain the following provisions for applicable types of radiation-generating devices:

1. American National Standards Institute Standard ANSI N43.3, "Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV," establishes acceptable guidelines for operations involving the irradiation of materials.

2. The provisions of HPS ANSI N43.2, "Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment," shall be adhered to for operations involving the following devices [see DOE O 5480.4 (2)(d)]:

   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, will establish the radiological control requirements for incidental x-ray devices such as electron microscopes and electron beam welders.

   Personnel operating cabinet x-ray systems such as those used by mailroom clerks and security are subject to the requirements of 21 CFR 1020.40, "Cabinet x-ray systems." These personnel are not required to be radiological workers solely for the purpose of operating these devices.

4. Devices for medical use will be registered with the appropriate regulatory agency.

5. Control requirements for radiographic devices include the following:

   a. On-Site operations with devices containing sealed sources for radiographic use will be conducted in accordance with the requirements contained in 10 CFR 34, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations."

   b. Acceptable guidelines are established in ANSI N43.3 for on-Site operations with devices other than sealed sources for radiographic use.

   c. On-Site operations conducted by off-Site subcontractors will be approved by line management in coordination with the Radiological Control organization. This

process will ensure that the subcontractor has a valid Nuclear Regulatory Commission or an agreement state license and that the operational and emergency procedures are current and available.

6. Required safety devices and interlocks at fixed installations shall be operational prior to and during generation of a radiation field [see 10 CFR 835.502]. Operational status will be verified by testing. Safety devices and interlocks will be fail-safe.

Part 7, Reserved

Part 8, Design and Control

Article 381, Radiological Design Criteria

The design objectives listed below are applicable during the design of new facilities and modification of existing facilities. Additional design criteria are provided in DOE O 420.1A.

1. For areas of continuous occupancy (2,000 hours per year), the design objective shall be to maintain the average exposure level ALARA and below 0.5 mrem per hour. If occupancy is not continuous, the design objective shall be to maintain doses ALARA and below 20% of the occupational dose limits provided in Table 2-1 [see 10 CFR 835.1002(b)].
2. For control of airborne radioactivity, the design objective shall be to avoid releases to the workplace atmosphere under normal conditions and, under any conditions, to control inhalation by workers to levels that are ALARA. Under normal conditions, confinement and ventilation shall be used [see 10 CFR 835.1002(c)].
3. For materials used in facility construction and modification, the design objective shall be to select materials that facilitate operations, maintenance, decontamination, and decommissioning [see 10 CFR 835.1002(d)]. Components will be selected to minimize the buildup of radioactivity. Control of surface contamination should be achieved by containment of radioactive material.
4. In justifying facility design and physical controls, optimization methods shall be used [see 10 CFR 835.1002(a)].
5. Support facilities should be provided for donning and removal of protective clothing and for personnel monitoring, when required.
6. A neutron 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 only. Design analyses based on these neutron quality factors are intended to provide an estimate of the additional construction cost resulting from increases in the neutron quality factor. The results of these analyses should be used to ascertain the economic feasibility of incorporating such modifications in the final design. This quality factor is not used for determination of individual dose equivalents.
7. Existing facility designs that have office space and lunchrooms or eating areas within radiological areas, radioactive material areas, and radiological buffer areas require priority attention. Generally:

a. Locating lunch rooms or eating areas, restrooms, drinking fountains, and 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 will be taken to preclude unnecessary occupancy.

8. Facilities currently under construction should be evaluated and the criteria in Article 381 should be applied where practicable.

Article 382, Control Procedures

1. Administrative control and procedural requirements shall be developed and implemented as necessary to supplement facility design features, particularly when the design of existing facilities does not comply with current standards [see 10 CFR 835.1001(b)]. Administrative control procedures include access control measures, RWPs, and technical work documents.

2. Written procedures shall be developed as necessary to ensure compliance with the provisions of ~~the RCM~~this manual that are derived from 10 CFR 835 [see 10 CFR 835.104]. These procedures shall be commensurate with the radiological hazards created by the activity and the education, training, and skills of the individuals who are exposed to these hazards [see 10 CFR 835.104].

3. Written authorizations, including specific radiation protection measures, shall be required to control entry into and work within radiological areas [see 10 CFR 835.501(d)]. These authorizations may include RWPs, technical work documents, administrative procedures, and other administrative controls.

4. The combination of design features and administrative control procedures shall be sufficient to ensure that, during routine operation, Table 2-1 dose limits for general employees are met and to ensure that doses are ALARA [see 10 CFR 835.1003(a).

Appendix 3A

Checklist for Reducing Occupational Radiation Exposure

Preliminary Planning and Scheduling Work

- Plan in advance.
- Cancel or do not perform unnecessary work.
- Determine expected radiation levels.
- Estimate the collective dose.
- Sequence jobs.
- Schedule the work.
- Select a trained and experienced work force.
- Identify and coordinate resource requirements.
- Plan access to and egress from the work area.
- Plan for installation of temporary shielding.
- Plan for decontamination.

Preparation of Technical Work Documents

- Include special radiological control requirements in technical work documents.
- Perform ALARA pre-job review.
- Select and optimize engineering and administrative controls to control doses.
- Specify requirements for standard tools.
- Consider special tools including robots.
- State staging requirements for materials, parts, and tools.
- Incorporate radiological control hold points.
- Analyze personal protective equipment requirements to ensure optimization of hazard control, risks, and costs.
- Minimize the discomfort of workers.
- Revise estimates of collective dose.
- Prepare radiological work permits (RWPs).

Temporary Shielding

- Remove or shield sources of radiation.

- Design shielding to include stress considerations.
- Control installation and removal by written procedure.
- Inspect after installation.
- Conduct periodic radiation surveys.
- Prevent damage caused by the weight of heavy temporary shielding.
- Balance radiation exposure received in installation against exposure saved by installation.
- Shield travel routes.
- Shield components with abnormally high radiation levels early in the maintenance period.
- Shield all positions occupied by workers.
- Perform directional surveys to improve the shielding design by locating the source of radiation.
- Use mockups to plan temporary shielding design and installation.
- Consider using water-filled shielding.

Rehearsing and Briefing

- Rehearse.
- Use mockups duplicating working conditions.
- Use photographs and videotapes.
- Conduct briefings of workers in accordance with Article 324.

Performing Work

- Work in the lowest radiation levels possible.
- Perform as much work as practicable outside radiation areas.
- Provide for service lines (air, welding, and ventilation).
- Provide communication (e.g., closed-circuit television or two-way radios).
- Comply with technical work documents and RWPs.
- Post radiation levels.
- Keep nonessential personnel out of radiation areas.
- Control radiation exposure while controlling exposure to other hazards.
- Track radiation exposures.
- Assist in radiation and radioactivity measurements.
- Delegate radiological control monitoring responsibilities.

- Evaluate the size of the work crew as work progresses.
- Compare actual dose against pre-job estimates.
- Coordinate personnel at the job site to reduce nonproductive time.
- Reevaluate methods used to control radiation doses.
- Compare the actual collective dose against the pre-job estimate of the collective dose.

Appendix 3B

Use of Protective Clothing and Contamination Control Practices

Selection of Protective Clothing

1. Workers will inspect protective clothing prior to use for tears, holes, or split seams that diminish protection. Any defective items will be replaced with intact protective clothing.
2. Protective clothing as prescribed by a radiological work permit will be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, areas of the body likely to be exposed to removable contamination, and regard for nonradiological hazards that may be present. Table 3-2 provides general guidelines for selection. As referenced in the table, a full set and double set of protective clothing typically includes the following items:

   Full set of protective clothing:

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

   Double set of protective clothing:

   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.

Donning Protective Clothing

1. Cotton glove liners may be worn inside standard gloves for comfort, but will not be worn alone or considered as a layer of protection.
2. Shoe covers and gloves should be sufficiently durable for the intended use. Leather or canvas work gloves should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.

3. Use of industrial safety equipment such as hard hats in contamination, high contamination, and airborne radioactivity areas should be controlled by the radiological work permit. Reusable industrial safety equipment designated for use in such areas should be distinctly colored or marked.
4. Shoe covers and gloves will be secured or taped at the coverall legs and sleeves when necessary to prevent worker contamination. Tape should be tabbed to permit easy removal.
5. 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.
6. Personal street 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.

Doffing Protective Clothing

Potentially contaminated protective clothing should be doffed without spreading contamination and in particular without contaminating the skin. Workers will 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. The instructions can be placed in another area if space or conditions do not allow the posting at the step-off pad.

Recommended Sequence for Doffing 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 each shoe onto a 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 depends on where the dosimetry was worn and the potential for contamination. The sequence for removal of respiratory protection devices may be altered if the potential for inhalation of airborne contamination or the spread of surface contamination can be reduced by keeping respiratory protection devices on until all protective garments have been removed.

Recommended Sequence for Doffing 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 shoe cover is removed.

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

9. Remove inner rubber gloves.
10. Remove inner coveralls, inside out, touching the inside only.
11. Take down the barrier closure, as applicable.
12. Remove tape or fastener from the inner shoe cover.
13. Remove each inner shoe cover, placing each shoe on a 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 depends on where the dosimetry was worn and the potential for contamination. The sequence for removal of respiratory protection devices may be altered if the potential for inhalation of airborne contamination or the spread of surface contamination can be reduced by keeping respiratory protection devices on until all protective garments have been removed.

Use of Multiple Step-Off Pads

Multiple step-off pads should be used to control egress from high contamination areas. These pads define interim control measures within the posted area to limit the spread of contamination. The following controls apply:

1. The inner step-off pad should be located immediately outside the highly contaminated work area, but still within the posted area.
2. Egress from high surface contamination areas may be through contamination areas to a step-off pad.
3. The worker should remove highly contaminated outer clothing prior to stepping on the inner step-off pad.
4. Additional secondary step-off pads, still within the posted area, may be used as necessary to restrict the spread of contamination out of the immediate area.
5. The final or outer step-off pad should be located immediately outside the contamination area.

Doffing Potentially Contaminated Firefighter Clothing

To facilitate the rapid egress of firefighters whose protective clothing is potentially contaminated, Radiological Control personnel should direct the firefighter in doffing firefighter clothing, which is commonly called bunker gear, using the guidelines listed below. The clothing items should be doffed into a suitable drum with a bag liner, surveyed at the earliest opportunity, and returned to the Fire Department if the clothing meets appropriate radiological release criteria.

The procedure requires that an assistant help the firefighter remove the firefighter clothing.

1. Firefighter and Assistant: Remove the firefighter's self-contained breathing apparatus, as follows.
    a. Firefighter: Place regulator in demand mode (as applicable).
    b. Firefighter: Disconnect the self-contained breathing apparatus hose from the regulator and carefully pull down (if applicable) on the regulator.
    c. Firefighter: Release the waist belt and chest strap.
    d. Firefighter: Loosen both self-contained breathing apparatus shoulder straps.
    e. Assistant (in appropriate radiological protective clothing): Support and remove the unit, and place it in the designated container.
2. Assistant: Loosen strap on helmet.
3. Firefighter: Bend forward (away from the radiological buffer area).
4. Assistant: Remove the helmet. Remove any duct tape from gloves. Place the helmet and tape in appropriate containers.
5. Firefighter: Extend arms horizontally.

6. Assistant: Roll back the cuff of each sleeve to the edge of the gloves, remove the firefighter's gloves and place in an appropriate container, and give the firefighter new gloves.
7. Firefighter: Don new gloves.
8. Assistant: Remove the face-piece-carrying strap, if applicable, from around the firefighter's neck by placing the face-piece-carrying strap over the firefighter's head and down to the hose piece.
9. Assistant: Release the topcoat buckle, open the collar strap, and lower the collar.
10. Firefighter: Lean forward, reach to the back of the hood, grasp the hood at the bottom on the outside, and pull the hood over the head and down, clearing the face-piece hose.
11. Firefighter: Lean forward slightly, away from radiological buffer area, grasp the face piece, and push the face piece down away from the chin, then forward away from the body.
12. Firefighter: Unfasten the bunker coat, grasp the outside of the coat, and pull the coat slightly off shoulders. Remove gloves, then swing arms behind.
13. Assistant: Remove coat by pulling on the sleeves. Place coat in appropriate container.
14. Assistant: Change own gloves and assist firefighter in donning a new set of gloves.
15. Firefighter: Remove suspenders from shoulders, grasp top edge of bunker pants, and release connectors securing bunker pants.
16. Firefighter: Push bunker pants down over the outside of the boots.
17. Assistant: Help firefighter step out of boots and bunker pants into the radiological buffer area. Place remaining gear in appropriate container.

Appendix 3C

Physical Access Controls for High and Very High Radiation Areas

1. One or more of the following shall be used for each entrance or access point to a high radiation area where radiation levels could cause an individual to exceed a whole-body dose of 1 rem in any 1 hour at 30 cm from the source or from any surface that the radiation penetrates [see 10 CFR 835.502(b)]:
   a. A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below the level defining a high radiation area.
   b. A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area.
   c. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.
   d. Entryways that are locked, except during periods when access to the area is required, with positive control over each entry.
   e. Continuous direct or electronic surveillance that is capable of preventing unauthorized entry.
   f. A control device that automatically generates audible and visual alarm signals to (1) alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area and (2) activate 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 that individuals are not able to gain unauthorized or inadvertent access to very high radiation areas when dose rates are in excess of the posting requirements of Table 2-3 [see 10 CFR 835.502(c)].
3. Physical access controls over high and very high radiation areas shall be established in a manner that does not prevent an individual from leaving the area [see 10 CFR 835.502(d)].

Appendix 3D

Guidelines for Personnel Contamination Monitoring with Hand-Held Instruments

General Approach

1. Verify that the hand-held contamination monitoring instrument is in service, has a valid source check, is set to the proper scale, and that the audio output can be heard during frisking.

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

3. Move the probe slowly over the surface, with the probe face (lengthwise if rectangular) achieving maximum coverage to the surface being monitored, approximately 2 in. 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 limit or the instrument alarms, remain in the area and notify Radiological Control personnel.

6. The whole-body frisk should take at least 2 to 3 minutes.

Sequence

1. Frisk the hands before picking up the probe.

2. Perform the frisk in the following order:

    a. Head (pause at mouth and nose for approximately 5 seconds).

    b. Neck and shoulders.

    c. Arms (pause at each elbow for approximately 5 seconds).

    d. Chest and abdomen.

    e. Back, hips, and seat of pants.

    f. Legs (pause at each knee for approximately 5 seconds).

    g. Shoe tops.

h. Shoe bottoms (pause at sole and heel for approximately 5 seconds).

i. Personnel and supplemental dosimeters.

3. Return the probe to its holder and leave the area. The probe should be placed on the side or face up to allow the next individual to monitor his/her hands before handling the probe.