U.S. Department of Energy Orders Self-Study Program

DOE STD-1098-2008

DOE STANDARD: RADIOLOGICAL CONTROL

DOE-STD-1098-2008
RADIOLOGICAL CONTROL
FAMILIAR LEVEL

OBJECTIVES

Given the familiar level of this module and the resources listed below, you will be able to answer the following questions:

1. What is the purpose of DOE-STD-1098-2008?
2. To which DOE position is the authority and responsibility to establish a comprehensive and effective radiological control training program assigned?
3. What is the definition of the term "total effective dose?"
4. What is the definition of the term "lifetime control level?"
5. What are three trigger levels that require a formal radiological review of work activities?
6. What are three planning activities that should be conducted prior to beginning radioactive processes that are conducted infrequently or for the first time?
7. What are three methods used to minimize the volume of mixed waste generated?
8. What are three reasons for evaluating radioactive drains?
9. Which individuals in a DOE facility should be provided personnel dosimetry?
10. What are three requirements for external dosimetry programs?
11. In what areas are area radiation monitors allowed in lieu of personnel dosimeters?
12. What actions should be taken if intakes of radioactive material are indicated that could result in an individual receiving a committed effective dose greater than 100 millirem?
13. What two elements must be included in general employee radiation training?
14. How can a worker challenge radiological worker I or II knowledge requirements?
15. What type of documents should be included in radiological control records?

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or the examples, complete the practice now. The course manager will check your work. You will need to complete the practice in this level successfully before taking the criterion test.

RESOURCES

10 CFR 835, "Occupational Radiation Protection." January 1, 2011.
10 CFR 835.103, "Education, Training, and Skills." January 1, 2011.
DOE-STD-1098-2008, Chg. 1, *DOE Standard: Radiological Control*. May 2009.
DOE-STD-1107-2007, Chg 1, *Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities*. November 2007.

INTRODUCTION

The familiar level of this module is divided into two sections. In the first section, we will discuss the highlights of chapters 1–4. Chapters 5–7 will be discussed in section two. The information provided in the module is limited to the guidance that is exclusive to DOE-STD-1098-2008.We have provided an example and a practice in the module to help familiarize you with the material. The practice will also help prepare you for the criterion test.

Before continuing, you should obtain a copy of DOE-STD-1098-2008 at http://www.hss.doe.gov/nuclearsafety/ns/techstds/standard.html or through the course manager. You should also be familiar with the other resources listed in this module as they may be required to answer questions in the practice and in the criterion test.

SECTION 1, CHAPTERS 1–4

Chapter 1, Excellence in Radiological Control

The radiological control program discussed in DOE-STD-1098-2008 goes beyond the scope of, and includes more details than, the documented radiation protection program (RPP) required by 10 CFR 835, "Occupational Radiation Protection." To ensure implementation of a comprehensive and coherent radiological control program that exceeds basic requirements and provides a substantial safety margin, DOE encourages its contractors to implement the provisions of DOE-STD-1098-2008 to the extent appropriate to facility hazards and operations, consistent with DOE's integrated safety management program. Should any conflicts arise between the site-specific radiological control manual and the documented RPP, the requirements of the documented RPP should take precedence. Such conflicts should be expeditiously resolved.

DOE-STD-1098-2008 is not a substitute for regulations; it is intended to be consistent with all relevant statutory and regulatory requirements and will be revised whenever necessary to ensure such consistency. Some of the provisions, however, challenge the user to go well beyond minimum requirements.

DOE-STD-1098-2008 is a living document. DOE intends to review and update provisions on a periodic basis to incorporate lessons learned and suggestions for improvement. The Chief Health, Safety and Security Officer is responsible for this task. Recommendations to correct or improve DOE-STD-1098-2008 are encouraged and should be processed in accordance with DOE's published guidance for providing comments on documents in the DOE technical standards system.

Leadership

Superior, consistent performance is achieved when qualified individuals use approved procedures and management actively monitors the workplace and assesses ongoing activities.

The DOE operations office manager and the contractor senior site executive should be familiar with the current radiological control performance record. Key principles common in a successful, well-managed radiological control program are provided in chapter 1.

- Senior managers should establish high standards for radiological control performance and frequently communicate these standards and management expectations to the work force.
- Senior managers should state in writing their firm commitment to a high-quality radiological control program. Management commitment and support should be demonstrated, in part, by allocating sufficient resources, including personnel, and providing for training to ensure workers are qualified for their assigned duties.
- Managers should ensure that orientation, training, and indoctrination reinforce rules and guidelines for each worker to control radiation exposure and radiological conditions.
- Managers should hold workers and their supervisors accountable for radiological control performance. Relevant knowledge and performance should be assessed as a specific part of each individual's performance evaluation. This assessment should not be limited to those who perform radiological work, since many other workers have an impact on the radiological control program.
- Senior managers should solicit feedback from their radiological control professionals, line management, and workers on radiological control performance.
- Senior managers should encourage initiatives to identify concerns at an early stage, to prevent conditions from deteriorating, and to promote doing the right job correctly the first time.
- Prevention of the spread of radioactive material is usually less costly than remediation. Management should accept change that will improve radiological control performance.
- 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.
- Senior managers should encourage minimizing the generation of radioactive waste and discharges to the environment, controlling contamination at its source, and minimizing radiation dose to workers and the public.
- The manager is responsible for fixing or mitigating a radiological problem, regardless of whether it has been reported to a superior.

Radiological Performance Goals

Managers and supervisors should establish goals to focus worker attention in specific areas. Following are goals that may be effective for reinforcing important elements of the radiological control program:

- Collective dose: This goal should be based on planned activities and historical performance.

- Skin and personal clothing contamination occurrences: Personnel contaminations may indicate a breakdown of controls intended to prevent the spread of contamination.
- Intakes of radioactive material: Management should focus attention on any failure of the controls that results in unplanned intakes.
- Contaminated area within buildings: Operating with a smaller contaminated area may result in less radioactive waste, fewer personnel contaminations, and improved productivity. The reduction of existing contaminated areas should be balanced by the recognition that this generates radioactive waste. Goals for both should be correlated.
- Radioactive waste: 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.
- Liquid and airborne radioactivity released: Minimizing effluents reduces the environmental impact of DOE operations and reduces the costs associated with remediation.
- The contractor senior management should establish, approve, and maintain a radiological control goals and performance indicator program.
- The radiological control goals should be measurable, achievable, auditable, and meaningful in promoting a sound radiological control program.
- Radiological control goals should be reviewed at least annually and revised as appropriate.

Some suggested radiological control performance indicators are listed in Table 1.

Table 1. Suggested radiological control performance indicators

Exposure Control ▪ Collective dose in person-rem ▪ Average worker dose in rem ▪ Maximum dose to a worker in rem ▪ Number of unplanned exposures resulting in doses greater than the facility administrative control level ▪ Number of dose assessments for lost or damage dosimeters
Personnel Contamination ▪ Number of skin and personal clothing contaminations ▪ Number of contaminated wounds ▪ Number of facial contaminations
Control of Internal Exposure ▪ Number of unplanned intakes ▪ Number of airborne events ▪ Number of alarms on airborne monitors ▪ Number of airborne radioactivity areas ▪ Area of airborne radioactivity areas in square feet
Control of Contaminated Areas in Operational Areas ▪ Number of contamination and high contamination areas ▪ Area of contamination areas in square feet ▪ Area of high contamination areas in square feet ▪ Number of spills requiring posting of an area
Minimization of Radioactive Waste ▪ Volume and activity of radioactive waste in cubic feet and curies, respectively ▪ Number of cubic feet not subject to volume reduction by incinerations, compaction, or other means
Control of Radioactive Discharges ▪ Activity of liquid radioactivity discharges in curies ▪ Activity of airborne radioactivity discharges in curies

Source: DOE-STD-1098-2008

Assessments

Assessment, as used in DOE-STD-1098-2008, refers to the process of providing independent feedback to senior line managers to indicate the adequacy of the radiological control program.

Inspections, audits, reviews, investigations, and self-assessments are part of the numerous checks and balances needed in a good radiological control program. Internal audits of the radiation protection program shall be conducted such that over a 36-month period, all functional elements are assessed. The audits should address program performance, applicability, content, and

implementation. These audits should be performed by the radiological control organization, the quality assurance organization, or other organizations having the requisite knowledge to adequately assess radiological control activities.

Internal Exposures

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

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

ALARA Committee

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

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

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

Radiological Control Coordinating Committee (RCCC)
The RCCC, as a minimum, consists of the radiological control program advisors from the Offices of the National Nuclear Security Administration, Science, Environmental Management, and Nuclear Energy, Science, and Technology, and representatives from the Office of Health, Safety, and Security, and selected operations offices and field organizations.

The RCCC is expected to receive and review suggestions, concerns, and comments from its individual members, operations offices, and contractors. The RCCC functions in a collective manner to promote a consistent and uniform emphasis in the direction and implementation of DOE-STD-1098-2008. Communications with the RCCC should follow standard administrative and reporting channels.

The RCCC should meet at least quarterly and more frequently during periods of transition.

RCCC meetings should include representatives from operations offices and field organizations and recognized industry experts from outside DOE. The interaction with non-DOE professionals enhances the awareness of state of-the-art technology and practices.

Chapter 2, Radiological Standards

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

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

Administrative Control Level

Approval by the appropriate secretarial officer or designee should be required prior to allowing an individual to exceed 2,000 millirem in a year.

Facility management should establish an annual facility administrative control level based on an evaluation of historical and projected radiation exposures, work load, and mission. This control

level should be reevaluated annually. The choice of a low level for one year does not preclude choosing either a higher or a lower level in a subsequent year. The facility administrative control level should be approved by the contractor senior site management.

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

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

Lifetime Control Level

Efforts should be made to control each individual's lifetime occupational dose below a lifetime control level of N rem where N is the age of the individual in years. This is applicable only to radiological workers because they are the only individuals expected to receive greater than 100 mrem in a year.

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

Special Control Levels

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

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

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

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

not to exceed the regulatory dose limits.

Chapter 3, Conduct of Radiological Work

Planning for Maintenance, Operations, and Modifications
Work plans and procedures should be reviewed to identify and incorporate radiological control requirements, such as engineering controls and dose and contamination reduction considerations. Performance of this review should be the responsibility of line management, with support and concurrence from the radiological control organization.

Where multiple hazards are present, this review should be performed by a multi-disciplinary team preparing the work control procedure. An integrated set of controls for all should be developed from this review.

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

- Estimated individual or collective dose greater than pre-established values
- Predicted airborne radioactivity concentrations in excess of pre-established values
- Removable contamination on accessible surfaces greater than pre-established values
- Entry into areas where dose rates exceed 1 rem/hour
- Potential releases of radioactive material to the environment

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

- Inclusion of radiological control hold points in the technical work documents
- Elimination or reduction of radioactivity through line flushing and decontamination
- Use of work processes and special tooling to reduce time in the work area
- Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity
- Specification of special radiological training or monitoring requirements
- Use of mock-ups for high exposure or complex tasks
- Engineering, design, and use of temporary shielding to reduce radiation levels
- Walkdown or dry-run of the activity using applicable procedures
- Staging and preparation of necessary materials and special tools
- Maximization of prefabrication and shop work
- Review of abnormal and emergency procedures and plans
- Identification of points where signatures and second party or independent verifications are required
- Establishment of success or completion criteria, with contingency plans to anticipate difficulties
- Development of a pre-job estimate of collective dose to be incurred for the job

- Provisions for waste minimization and disposal
- Identification of potential environmental releases

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

Radiological control requirements identified as part of the radiological review should be documented in the job plans, procedures, or work packages. Line management and the radiological control organization should provide enhanced oversight during the initiation and conduct of the work.

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

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.

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

The RWP should be integrated with other work authorizations that address safety and health issues, such as those for industrial safety and hygiene, welding, or confined space entry. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in DOE-STD-1098-2008. The RWP should include the following information, unless the information is contained in other related work-control documents:

- Description of work
- Work area radiological conditions
- Dosimetry requirements, including any bioassay requirements
- Pre-job briefing requirements, as applicable
- Training requirements for entry
- Protective clothing and respiratory protection requirements
- Radiological control coverage requirements and stay time controls, as applicable
- Limiting radiological conditions that may void the RWP
- Special dose or contamination reduction considerations
- Special personnel frisking considerations
- Technical work document number, as applicable

- Unique identifying number
- Date of issue and expiration
- Authorizing signatures.

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

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

RWPs should be used to control the following activities:

- Entry into radiological areas
- Handling of materials with removable contamination that exceed the values of table 2-2 in DOE-STD-1098-2008
- Work in localized bench-top areas, laboratory fume hoods, sample sinks, and containment devices that has the potential to generate contamination in areas that are otherwise free of contamination
- Work that disturbs the soil in soil contamination areas
- Work that involves digging in underground radioactive material areas

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

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

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

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

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

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

Radiological Work Controls

Work Control and Practices

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

- Monitor contamination levels caused by ongoing work and maintain them ALARA. Curtail work and perform decontamination at pre-established levels, taking into account worker exposure.
- Inspect tools and equipment to verify operability before being brought into contamination, high contamination, or airborne radioactivity areas.
- Minimize the use of radiologically clean tools or equipment in contamination, high contamination, or airborne radioactivity areas by implementation of a contaminated tool crib. When such use is necessary, consider wrapping or sleeving tools or equipment in complex or inaccessible areas to minimize contamination.
- Install engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, in accordance with the technical work documents and inspect them prior to use.
- Verify the identity of components and systems prior to work.
- Schedule work activities and shift changes to prevent idle time in radiological areas.
- Where practicable, remove parts and components to areas with lower radiological hazards to perform work.
- 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.
- Include requirements for area cleanup in technical work documents.
- To minimize intakes of radioactive material, do not permit smoking, eating, or chewing in contamination, high contamination, or airborne radioactivity areas. When the potential for personnel heat stress exists, drinking may be permitted within a contamination area under the following conditions and controls:
  - The potential for heat stress cannot be reduced by the use of administrative or engineering controls.
  - All drinking is from approved containers or sources.
  - The applicable requirements and controls are described in approved procedures.
- Check communication systems required by the radiological work permit or technical work document for operability before being brought into the work area and periodically during work.
- Workers should keep radiological control personnel informed of the status of work activities that affect radiological conditions.

Response to Abnormal Situations

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

- Response to a continuous air monitor alarm should include the following actions:
  - Stop work activities and place the area in a safe condition.
  - Exit the area.
  - Notify radiological control personnel.
- Response to increasing or unanticipated radiation levels, as identified by a supplemental dosimeter or area radiation monitor alarm, should include the following actions:
  - Stop work activities and place the area in a safe condition.
  - Alert others.
  - Affected individuals exit the area.
  - Notify radiological control personnel.
- Response to a criticality alarm should include the following actions:
  - Immediately evacuate the area, without stopping to remove protective clothing or perform exit monitoring.
  - Report to designated assembly area.
- Response to a personnel contamination monitor alarm should include the following actions:
  - Remain in the immediate area.
  - Notify radiological control personnel.
  - Take actions to minimize cross-contamination, such as putting a glove on a contaminated hand.
  - Take follow-up actions in accordance with article 541 of DOE-STD-1098-2008.
- Response to a spill of radioactive material should include the following actions:
  - Stop or secure the operation causing the spill.
  - Warn others in the area.
  - Isolate the spill area if possible.
  - Minimize individual exposure and contamination.
  - Secure unfiltered ventilation.
  - Notify radiological control personnel.

Controls for Bench-top 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 bench-top areas, laboratory fume hoods, sample stations, glovebags, and glovebox operations located in areas that are otherwise contamination free.

- Provisions for radiological work permits are provided in DOE-STD-1098-2008.
- Protective clothing should, at a minimum, include lab coats and gloves. Gloves should be secured at the wrist as necessary to prevent forearm contamination.

- Shoe covers should be considered based on the potential for floor contamination.
- Workers should periodically monitor their hands during work, change contaminated gloves and notify the radiological control organization of unexpected levels of contamination.
- Upon completion of work or prior to leaving the area, workers should monitor those areas of their body that are potentially contaminated. At a minimum, this includes hands, arms, and front portions of the body. A whole body frisk is recommended. If the working area was a contamination area, high contamination area, or airborne radioactivity area, workers shall monitor those areas of their body that are potentially contaminated.
- 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 protective clothing, or respiratory protection should be considered.
- Gloveboxes should be inspected for integrity and operability prior to use.
- Gloveboxes should be marked with, or survey measurements should be posted to identify, whole body and extremity dose rates.

Controls for Hot Particles

Measures for controlling hot particles should be implemented under the following conditions:

- Upon identification of hot particles.
- During new or non-routine operations with a high potential for hot particles, based on previous history.
- Upon direction of the radiological control organization.
- Survey provisions for areas or operations with the potential for hot particle contamination are established in article 554.9 of DOE-STD-1098-2008.
- Contamination area postings should be annotated to specifically identify the presence of hot particles.
- Access to hot particle areas should be controlled by an RWP. The following controls should be considered for inclusion on the RWP:
  - Periodic personnel monitoring during the work activity, at a frequency based on the potential magnitude of personnel exposure
  - Additional personal protective equipment and clothing
  - Direct radiological control coverage during work and assistance during protective clothing removal
  - Use of sticky pads or multiple step-off pads.
- 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.
- Response to hot particle skin or clothing contamination should include the following:
  - Immediate removal and retention of the hot particle for subsequent analysis
  - Analysis of the particle
  - Assessment of worker dose
  - Evaluation of work control adequacy

Conduct of Critiques

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

- Critiques should be conducted for successes and abnormal events.
- 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.
- At a minimum, the general critique process should include the following elements:
  - Formal meetings, chaired by a critique leader
  - Attendance by members of the work force who can contribute
  - Attendance records
  - Minutes signed by the critique leader
  - A listing of the facts in chronological order
  - Supporting materials, including documents, records, photographs, parts, and logs, maintained by the critique leader
  - Lessons learned
- Evaluation of complex evolutions or events may require multiple critiques.

CHAPTER 4, RADIOACTIVE MATERIALS

Control of Radioactive Drains

Radioactive drain systems are designed to transport radioactive liquids. Improper use may cause an environmental release.

- Radioactive drain systems should not discharge to the environment nor be used for the disposal of non-radioactive liquids.
- Existing radioactive drains should be evaluated to ensure the following:
  - Verification of the existing radioactive drain piping configuration
  - Installation of flow-indicating devices in leak-off lines
  - Use of plugs to prevent non-radioactive input
  - Consideration of alternative work controls before systems are drained for maintenance
  - Controls prohibiting unauthorized use of drains
- Modifications to the design or operation of existing radioactive drain systems should be controlled to include the following:
  - Design considerations that prevent non-radioactive drain connections into radioactive drains
  - Procedural and design controls to prevent cross-connections of radioactive drains with non-radioactive systems
  - Management review of subsequent changes to the design of radioactive drain systems or radioactive drain controls
  - Management controls to restrict the introduction of hazardous wastes into radioactive drain systems

Control of Airborne Radioactivity

The radiological control organization should be notified when engineering controls that prevent worker exposure to airborne radioactivity, such as barriers, gloveboxes, and glovebags, are compromised. An evaluation should be made of continuing operations with compromised engineering controls. The use of respiratory protection to continue activities under these conditions is discouraged. Implementation of short-term engineering modifications that provide a commensurate level of worker protection is the preferred alternative.

Preventive maintenance and surveillance procedures should be established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

Controls and Monitoring of Personal Protective Equipment and Clothing

Except for disposable, single-use items, protective clothing designated for radiological control use should be specifically identified by color, symbol, or appropriate labeling.

Protective clothing designated for radiological control use should not be used for non-radiological work.

Personal protective equipment and clothing should not be stored with personal street clothing.

Cleaned personal protective equipment, such as face shields and respirators that comes into contact with the wearer's face and company-issued clothing should be surveyed prior to reuse. Contamination levels should be below table 2 total contamination values prior to reuse.

Table 2. Summary of Surface Contamination Values in dpm/100cm^2

Radionuclide	Removable	Total (Fixed + Removable)
U-nat, U-235, U-238, and associated decay products	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I 129	20	500
Beta-gamma emitters except Sr-90 and those listed above	200	1,000
Tritium and special tritium compounds	10,000	See Note

Note: Tritium contamination including special tritium compounds may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface to ensure the surface contamination value is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a total value does not apply. In certain cases, a total value of 10,000 dpm/100 cm^2 may be applicable either to metals of the types from which insoluble special tritium compounds are formed, that have been exposed to tritium, or to bulk materials to which insoluble special tritium compound particles are fixed to a surface.

Laundered protective clothing should be surveyed and should meet the following criteria prior to reuse:

- Beta-gamma radioactivity less than 10,000 dpm/100 cm^2
- 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.

Sites and facilities are encouraged to continue efforts to reduce contamination levels on reusable personal protective equipment and clothing.

Decontamination

Radiological work permits or technical work documents should include provisions to control contamination at the source to minimize the amount of decontamination needed.

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

Decontamination activities should be controlled to prevent the spread of contamination.

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.

Facility line management should be responsible for directing decontamination efforts.

Note: You do not have to do example 1 on the following page, but it is a good time to check your skill and knowledge of the information covered. You may do the example 1 or go to section 2.

EXAMPLE 1

1. What are two suggested radiological control performance indicators for exposure control?

2. What is the goal of the ALARA committee?

3. What are two trigger levels that would require a formal radiological review of work activities?

Note: When you are finished, compare your answers to those contained in example 1 self-check. When you are satisfied with your answers, go on to section 2.

EXAMPLE 1 SELF-CHECK

1. What are two suggested radiological control performance indicators for exposure control?
   Note: Any two of the following comprise a complete answer.
   Suggested radiological control performance indicators for exposure control are:
   - Collective dose in person-rem
   - Average worker dose in rem
   - Maximum dose to a worker in rem
   - Number of unplanned exposures resulting in doses greater than the facility administrative control level
   - Number of dose assessments for lost or damaged dosimeters

2. What is the goal of the ALARA committee?
   The goal of the ALARA committee should be to promote the optimization of personnel exposure to workers and the public.

3. What are two trigger levels that would require a formal radiological review of work activities?
   Note: Any two of the following comprise a complete answer.
   The following are example trigger levels:
   - Estimated individual or collective dose greater than pre-established values
   - Predicted airborne radioactivity concentrations in excess of pre-established values
   - Removable contamination on accessible surfaces greater than pre-established values
   - Entry into areas where dose rates exceed 1 rem/hour
   - Potential releases of radioactive material to the environment

SECTION 2, CHAPTERS 5-7

Chapter 5, Radiological Health Support Operations

External Dosimetry

General Provisions

Dosimeters should be issued only to individuals knowledgeable of their proper use and worn only by those to whom the dosimeters were issued.

To minimize the number of individuals in the dosimetry program, DOE discourages the issuance of dosimeters to individuals other than those entering areas where there is a likelihood of external exposure in excess of the monitoring thresholds. Although issuing dosimeters to individuals who are not occupationally exposed to radiation can appear to be a conservative practice, it creates the impression that the wearers are occupationally exposed to radiation. Implementation of an unnecessarily broad dosimetry program is not an acceptable substitute for development of a comprehensive workplace monitoring program.

Individuals should return dosimeters for processing as scheduled or upon request, and should be restricted by line management from continued radiological work until dosimeters are returned.

Individuals should wear their primary dosimeters on the chest area, on or between the waist and the neck, or in the manner prescribed by radiological control procedures or work authorizations.

Film dosimeters should not be worn or taken offsite unless specifically authorized by the radiological control manager or designee.

DOE discourages the practice of taking thermoluminescent dosimeters offsite.

Individuals should not wear dosimeters issued by their resident facilities while being monitored by a dosimeter at another facility unless authorized by the radiological control manager or designee. Individuals should not expose their dosimeters to security X-ray devices, excessive heat, or medical sources of radiation.

Technical Provisions for External Dosimetry

Facilities are encouraged to participate in inter-comparison studies for external dosimetry programs.

Multiple dosimeters should be issued to individuals to assess effective dose in non-uniform radiation fields. Non-uniform radiation fields exist when the dose to a portion of the whole body will exceed the dose to the primary dosimeter by more than 50 percent and the anticipated whole body dose is greater than 100 millirem. When the radiation field is well characterized and the worker's orientation is known, relocation of the primary dosimeter is permitted in lieu of issuance of multiple dosimeters. Under such conditions, the individual's dosimeter should be relocated to the portion of the whole body likely to receive the highest dose. Dosimeter relocation should be conducted in conformance with facility procedures or specific work authorizations, such as RWPs. The technical basis document should describe the methodology used in determining the dose of

record when multiple dosimeters are used and when dosimeters are relocated.

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

Monitoring programs implemented at the discretion of the contractor need not be accredited under the DOE laboratory accreditation program for personnel dosimetry (DOELAP) program. Programs implemented outside the scope of the DOELAP program should include the following:

- Documented assessment of each individual's potential occupational dose to support the decision to operate outside the DOELAP Program. Such assessments should be based on facility design reviews, the results of a comprehensive workplace monitoring program, and, if available, the results of previous individual monitoring results.
- Comprehensive routine surveys of areas that may be entered by these individuals to ensure that individual doses are not likely to exceed the monitoring thresholds.

Area Monitoring Dosimeters

Establishment and maintenance of a comprehensive area monitoring program can minimize the number of areas requiring the issuance of personnel dosimeters and demonstrate that doses outside radiological areas are negligible. Minimizing the number of personnel dosimeters issued saves in the costs of operating the dosimetry program and reduces costs associated with maintaining personnel with enhanced training and qualifications.

Area monitoring dosimeters may be used to record and document radiation levels in routinely occupied areas adjacent to areas where radiation or operations with radiation exist. This monitoring provision does not apply when the radiation arises solely from low-energy beta sources.

Area monitoring dosimeter results may be used to support dosimetry investigations where individuals express concerns about their work environments and exposure to ionizing radiation.

Area monitoring dosimeters may be used in controlled areas to supplement existing monitoring programs and to provide data in the event of an emergency.

Internal Dosimetry

General Provisions

Individuals should participate in follow-up bioassay monitoring when their routine bioassay results indicate an intake in the current year with a committed effective dose of 100 millirem or more.

Individuals whose routine duties may involve exposure to surface or airborne contamination or to radionuclides readily absorbed through the skin, such as tritium, should be considered for participation in the bioassay program.

The bioassay program should establish appropriate frequencies for the collection of bioassay samples, such as urine or fecal samples, and participation in bioassay monitoring, such as whole body or lung counting. Individuals should participate at the frequency required by the bioassay program.

Technical Provisions for Internal Dosimetry

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

Baseline bioassay monitoring of individuals who are likely to receive intakes resulting in a committed effective dose greater than 100 millirem in a year should be conducted before they begin work that may expose them to internal radiation exposure.

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

Management should request termination bioassay monitoring when an individual who participated in the bioassay program terminates employment or concludes work involving the potential for internal exposure.

Bioassay analyses should also be performed when any of the following occurs:

- Facial or nasal contamination is detected that indicates a potential for internal contamination exceeding any monitoring threshold.
- Airborne monitoring indicates the potential for intakes exceeding 100 millirem committed effective dose.
- Upon direction of the radiological control organization when an intake is suspected.

Levels of intakes that warrant the consideration of medical intervention should be established for site-specific radionuclides. The effectiveness of medical intervention, such as blocking or chelating agents, should be documented using bioassay results.

A preliminary assessment of intakes detected should be conducted prior to permitting an employee to return to radiological work.

Internal dosimetry program personnel should use radionuclide standards from or traceable to the National Institute of Standards and Technology.

Internal dosimetry program personnel are encouraged to participate in inter-comparison studies and to use the DOE phantom library.

Bioassay programs implemented at the discretion of the contractor need not be accredited under the DOELAP program. Programs implemented outside the scope of the DOELAP program should include the following:

- Documented assessment of each individual's potential occupational exposure to support the decision to operate outside the DOELAP program
- Comprehensive monitoring of the areas that may be entered by these individuals to ensure that individual doses are not likely to exceed the monitoring thresholds

Respiratory Protection Program

Use of Respiratory Protection

The use of respiratory protection devices can impair worker mobility and vision and cause worker discomfort and stress.

For these reasons, the issue and use of respiratory protective devices must be controlled.

Individuals using respiratory protection shall

- perform fit checks of close-fitting respirators to ensure a proper seal before entering areas requiring respirator use;
- be clean shaven in the area of fit, if applicable;
- use corrective lenses, if needed that are approved for respirators;
- be trained to leave the work area when experiencing respirator failure;
- be trained to remove their respirators to avoid life-threatening situations when exiting an area after respirator failure.

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, as applicable.

Job supervisors should inform their personnel of heat stress precautions prior to work on job assignments in hot environments. Precautions that should be considered during work that includes a high probability of heat stress include the following:

- Engineering controls to moderate the work area environment
- Appropriate work time limits
- Use of protective clothing made of materials that wick perspiration away from the body
- Use of body cooling devices
- Provision of beverages at or near the work site, using appropriate contamination controls
- Relaxation of protective clothing requirements

If an individual begins to feel symptoms of heat illness, the individual should immediately notify the nearest coworker, exit the area, remove personal protective equipment, notify the supervisor, and rest in a cool area. In such cases, medical assistance should be provided.

Handling Radiologically Contaminated Personnel

Skin Contamination

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

When personnel detect skin contamination, they should notify the radiological control organization.

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

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.

Levels of skin contamination that trigger the need for dose assessments should be established for site-specific radionuclides. These trigger levels should not exceed 100 millirem.

Individuals with skin contamination that triggers the need for dose assessment should be informed of the initial dose estimate to their skin as soon as practicable, preferably prior to the end of their work day.

Individuals with skin contamination for which dose assessment was not performed should be informed of the nature of the contamination and an upper estimate on the potential dose (such as less than 10 millirem) as soon as practicable, preferably prior to the end of their work day.

An assessment of skin exposure requires time to conduct a detailed evaluation. Promptly after completion, the results should be explained to the persons affected.

Contaminated Wounds

Emergency medical care should be administered immediately for injuries involving radioactive materials. Medical treatment of injuries takes precedence over radiological control considerations. The treatment of contaminated injuries should include the following:

- Treatment of contaminated wounds by medically qualified personnel
- Monitoring of wounds and associated bandages for contamination, including alpha emitters if applicable
- Identification of the radionuclides involved
- Medical determination of the need for therapeutic intervention such as blocking or chelating agents
- Initiation of appropriate bioassay monitoring
- Determination of need for work restrictions

Handling Individuals Exposed to Airborne Radioactivity

Potential intakes of radioactive material are indicated when individuals without respiratory protection are exposed to airborne radioactivity or when respiratory protection has been compromised. If intakes of radioactive material are indicated which could result in an individual

receiving a committed effective dose greater than 100 millirem, the following actions should be taken:

- Identify individuals potentially exposed to airborne radioactivity.
- Obtain nasal smears for qualitative indication of intakes where appropriate.
- Analyze air samples to determine airborne concentrations where appropriate.
- Determine duration of potential exposure to airborne radioactivity.
- Perform bioassay appropriate for the type and quantity of radionuclides involved.
- Evaluate dose prior to permitting the worker to return to radiological work.

Radiological Monitoring

General Provisions

Monitoring for radiation, contamination, and airborne radioactive materials should be performed as specified in technical work documents and radiological work permits.

The radiological control organization should perform and document a review of the adequacy of sampling and monitoring programs as part of any facility or operational changes affecting radiological control. In the absence of such changes, a review should be conducted annually.

Instruments used to perform radiation monitoring should be performance-checked daily or, if not checked within the past 24 hours, prior to operation. When performance checks are not within ±20 percent of the expected value, the instrument should be taken out of service. When performance checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance.

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

Monitoring should be performed before, during, and at the completion of work that has the potential for causing changes in levels of radiation and radioactivity.

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

Monitoring results should be reviewed by the cognizant radiological control supervisor to ensure that all required surveys have been performed and that the documentation is accurate and complete.

Results of current surveys or survey maps should be conspicuously posted to inform personnel of the radiological conditions.

Survey results should be made available to line management and used in support of pre- and post-job evaluations, preparation or selection of appropriate radiological work permits, ALARA preplanning, contamination control, and management of radiological control operations.

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.

Radiation Exposure Monitoring

Routine radiation monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based upon facility-specific experience:

- Daily, in office space located in radiological buffer areas and other areas surrounding radiological areas where the potential exists for external radiation exposure
- Weekly, in routinely occupied radiological buffer areas and radiation areas
- Weekly, for operating HEPA-filtered ventilation units
- Weekly, for temporary radiation area boundaries to ensure that radiation areas do not extend beyond posted boundaries
- Monthly, or upon entry, if entries are less frequent than monthly, for radioactive material areas
- Monthly, for potentially contaminated ducts, piping, and hoses in use outside radiological facilities

Radiation monitoring should include dose rate measurements of the general area, dose rates at a distance of 30 centimeters from a source or surface of interest to evaluate potential whole body exposures, and dose rates on contact with potential sources of radiation where there is a potential for hands-on work or other direct contact.

Monitoring should be conducted whenever operations are being performed that might result in individuals being exposed to small intense beams of radiation, such as those generated by shielded X-ray devices or due to removal or alteration of shielding, modification of shielding penetrations, or relocation of significant radiation sources within shielded enclosures.

Area Radiation Monitors

Area radiation monitors should be installed in frequently occupied locations with the potential for unexpected increases in dose rates and in remote locations where there is a need for local indication of dose rates prior to personnel entry.

Area radiation monitors should not be substituted for radiation exposure surveys in characterizing a workplace.

The need for and placement of area radiation monitors should be documented and assessed when changes to facilities, systems, or equipment occur.

Area radiation monitors should be tested periodically to verify audible alarm system operability and audibility under ambient working conditions and operability of visual alarms when so equipped.

If installed instrumentation is removed from service for maintenance or calibration, a radiation monitoring program providing similar detection capability should be provided, consistent with the

potential for unexpected increases in radiation dose rates.

Contamination Monitoring

Contamination monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based on facility-specific experience:

- Prior to transfer of equipment and material from one radiological buffer area established for contamination control to another, unless the material was monitored immediately prior to this transfer, such as upon removal from a contamination area
- Prior to transfer of equipment and material from high contamination areas within radiological buffer areas unless precautions such as bagging or wrapping are taken prior to transfer
- Daily, at contamination area control points, change areas, or step-off pads when in use, or per shift in high use situations
- Daily, in office space located in radiological buffer areas
- Daily, in lunch rooms or eating areas near radiological buffer areas
- Daily in accessible areas where operations are under way that are likely to produce hot particles
- Weekly, in routinely occupied radiological buffer areas
- Weekly, or upon entry if entries are less frequent, in contamination areas and other areas where materials having removable contamination exceeding the table 2 values are handled or stored
- Weekly, or upon entry if entries are less frequent, where contamination area boundaries or postings are located
- During initial entry into a known or suspected contamination area, periodically during work, at completion of job, or as specified in an RWP
- Monthly, in and around areas of fixed contamination
- After a leak or spill of radioactive materials

Airborne Radioactive Monitoring

Air sampling equipment should be positioned to measure air concentrations to which individuals are exposed. If this cannot be achieved, a program of personal breathing-zone air sampling should be initiated. Air monitoring programs should be established to ensure that airborne radioactivity monitoring is performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. Selection of air monitoring equipment should be based on the specific job being monitored. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors.

Real-time air monitoring equipment should have alarm capability and sufficient sensitivity to alert individuals that immediate action is necessary to minimize or terminate inhalation exposures.

A technical basis document should be developed for the airborne radioactivity monitoring program.

The technical basis document should provide the basis for air monitor selection, placement, and operation.

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

Preliminary assessments of air samples utilizing field survey techniques should be performed promptly on 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.

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.

Site-specific temporal and spatial averaging techniques may be used in determining the requirements for air monitoring. Justification for these techniques should be documented and retained and the results of these analyses used in documentation of the RPP.

Instrumentation and Calibration

Inspection, Calibration, and Performance Tests

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

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

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.

Measures should be implemented to ensure that individuals using an instrument can verify its calibration status.

Instruments whose as-found readings indicate that the instrument may have been used while out of calibration should be reported to the radiological control organization. The radiological control organization should review surveys performed with the instrument while it was out of calibration

and consider the need for additional surveys.

Maintenance

A program for preventive and corrective maintenance of radiological instrumentation should be established and documented.

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.

Radiological instruments should undergo calibration prior to use following any preventive or corrective maintenance or any adjustment that voids the previous calibration. A battery change is not normally considered maintenance.

Chapter 6, Training and Qualification

Radiological Control Training and Qualification

General Requirements

The provisions of chapter 6 ensure that individuals are trained to work safely in and around radiological hazards and to maintain their individual radiation exposure and the radiation exposures of others ALARA. Training provisions in chapter 6 apply to individuals entering controlled areas at DOE sites and other individuals who are responsible for developing and implementing radiological control measures.

DOE's core course training material, supplemented by site-specific training materials, should be used to the extent practicable to satisfy the training requirements.

Successful completion of the entire core academic component of a DOE core course at one DOE site within the past two years should be recognized by other DOE sites. Allowances may also be made for individuals who have successfully completed other types of radiological control training.

Measures should be implemented to ensure that each individual's current training status can be assessed as necessary to ensure appropriate job assignments and to permit effective entry control. Appropriate measures include electronic databases or wallet-sized training certificates that identify current training status.

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

Verification of the effectiveness of radiation safety training should be accomplished by surveying a limited subset of former students in the workplace. This verification is in addition to performance evaluations routinely performed by training departments. This evaluation should include observation of practical applications and discussions of the course material and may include written examinations. The survey should be performed by radiological control managers and supervisors,

quality assurance personnel, or senior instructors after the former student has had the opportunity to perform work for several months. The results should be documented and may be used to identify the need for remedial training.

Training programs developed for radiation safety should meet the requirements for performance-based training.

Reading and comprehension skills in the English language are generally necessary for radiation safety training.

The radiological control manager is authorized to approve alternative measures for those lacking reading and comprehension skills in the English language until adequate English language skills can be achieved. Training in an alternate language should be equivalent to training in English. The alternative measures should be sufficient to ensure that the affected individuals can respond appropriately to any audible or visible warnings that they may encounter in the facility. Orientation and the use of trained escorts provide an alternate to training with the concurrence of the radiological control manager.

The site radiological control manager or designee should concur in radiation safety training material.

Requirements and guidance for training records and course documentation are provided in article 725 of DOE-STD-1098-2008.

Instructor Training and Qualifications

All instructors should be qualified in accordance with the contractor's site instructor qualification program or possess equivalent qualifications.

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

Instructors-in-training should be monitored by a qualified instructor.

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.

General Employee Radiological Training

Site Personnel

Individuals shall complete radiation safety training prior to unescorted access to controlled areas and prior to receiving occupational radiation exposure during access to controlled areas. This training shall address radiation safety training topics to the extent appropriate for the degree of exposure to radiological hazards that may be encountered and the required controls.

General employee radiological training (GERT) should include DOE's core course training materials, as applicable, and should be expanded to include site-specific information, such as site-specific radiation types, alarm responses, and policies. This site-specific information may be included in GERT, or in facility orientations.

Workers may challenge GERT core knowledge requirements by passing a comprehensive examination. If unsuccessful in one attempt, the entire GERT standardized core training should be completed. Challenges should not apply to the site-specific portions.

Additional training beyond GERT should be required for unescorted entry into radiological buffer areas or areas posted for radiological control other than controlled areas.

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

In the alternate year when full training is not completed, the latest GERT handbook should be available for self-study.

If an escort is used in lieu of training, then the escort shall have completed the level of training required for the areas to be entered and the work to be performed and shall ensure that the escorted individual complies with the radiation protection program.

Radiological Safety Training and Orientation for Members of the Public

DOE encourages its operating entities to continuously escort members of the public in the controlled area. However, when members of the public are trained, the following additional criteria should be met prior to permitting unescorted access to controlled areas:

- Prior approval by the radiological control manager.
- Appropriate limitations are established on the areas to be entered and the activities to be undertaken to prevent occupational exposure.
- The individual receives enhanced training providing information commensurate with the areas to be entered and activities to be undertaken while unescorted.

Members of the public, including tour groups and visiting dignitaries, who enter the controlled area and are continuously escorted, should receive a radiological safety orientation. This orientation should include the following topics and be commensurate with the hazards present in the areas to be entered and the required controls:

- Risk of low-level occupational radiation exposure, including cancer and genetic effects
- Risk of prenatal radiation exposure
- Member of the public and management responsibilities for radiation safety
- Adherence to radiological posting and labeling
- Applicable emergency procedures
- Training for issuance of dosimeters, where applicable.

Information may be communicated by classroom lecture, videotape, or other appropriate methods. An examination is not required.

Sign-in logs may be used as radiation safety training and orientation records as required.

Radiological Worker Training

General Provisions

Each individual shall demonstrate knowledge of the radiation safety training topics commensurate with the hazards in the area and required controls, by successful completion of an examination and appropriate performance demonstrations prior to being permitted unescorted access to radiological areas and prior to performing unescorted assignments as a radiological worker. Radiological worker training should include the DOE's core course training materials, as applicable, and should be expanded to include site-specific information.

Workers may challenge DOE's radiological worker I or II core knowledge requirements by passing a comprehensive examination. If unsuccessful in one attempt, the entire standardized core radiological worker I or II training should be completed. Challenges should not apply to the site-specific portions.

Radiological worker I training is not a prerequisite for radiological worker II training.

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.

Individuals with current radiological worker I training may be upgraded to allow unescorted access to other areas by completing only the additional training provided in radiological worker II training.

In the alternate year when training is not performed, refresher training should be completed.

Qualification Standards for Radiological Control Technicians (RCTs)

Qualification standards define the requirements for demonstrating completion of training. Signatures on the forms in qualification standards provide documentation of satisfactory proficiency.

The qualification standards from the standardized core course should be supplemented to include site-specific elements.

Qualification standards for the RCT position should include on-the-job training to provide hands-on experience directly applicable to the job.

Oral Examination Boards

The oral examination board provides an opportunity to identify areas of strength and weakness related to performance of RCT duties and supervisor functions. The oral examination board also provides the opportunity to identify additional training needs to enhance RCT and supervisor training programs.

The radiological control manager should consider using an oral examination board to determine the initial qualification and requalification of candidates for RCT and supervisor positions.

The radiological control manager should designate the board members and appoint a chairperson.

The board constituted to evaluate RCT qualification should be composed of at least three persons to include an RCT supervisor, radiological control staff, and line management operations department supervisors and staff personnel, as applicable. RCT instructors may participate as non-voting members.

The board should assess the candidate's response to normal and emergency situations. Questions should be of the type that is not normally covered in a written examination.

The board constituted to evaluate RCT supervisor qualification should not include peers or subordinates as voting members.

Continuing Training

Following initial qualification, the RCT should begin a two-year cycle of continuing training required for requalification.

Every requalification should include completion of practical training and a comprehensive written examination. A final oral examination board is encouraged.

Continuing training should provide continued improvement in the knowledge and skills of the RCT.

Continuing training should include site-specific and DOE-wide changes in requirements and updates of lessons learned from operating experience and industry events.

Continuing training should include written examinations as applicable, demonstrations of proficiency controlled by qualification standards, and oral examinations as needed to ensure understanding of the topic.

Infrequently performed tasks, such as those for emergency response, may require annual training. Other tasks may require training prior to initiation.

RCT Supervisors

Because of the nature of their duties, RCT supervisors would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 "Education, Training, and Skills." Training and education standards for RCT supervisors should be consistent with DOE-STD-1107-2007, Chg. 1, *Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities*.

RCT supervisors should have supervisory and leadership capabilities to direct the work of technicians; effectively interact with crafts, line supervisors, professional staff, and other managers;

and be able to respond and direct others in emergency and abnormal situations.

RCT supervisors' knowledge of facility radiological control hazards, programs, and procedures should be reassessed every two years. DOE encourages the use of comprehensive oral examination boards.

Oral examination boards should focus on the ability to analyze situations and supervise subordinates. The RCT supervisor's depth of knowledge should exceed that expected of an RCT.

Chapter 7, Radiological Control Records

Purpose
Chapter 7 prescribes practices for preparing and retaining radiological control records. The work force and management are required to use records to document radiological safety afforded to individuals onsite. Records of radiological control programs may be required to support worker health studies and future disputes or claims. Therefore, these records should be high quality, readily retrievable, and managed for the prescribed retention period. Consideration should be given to cross-referencing related records to aid retrievability. Records should be handled such that personal privacy is protected.

Recordkeeping Standards
Radiological control records should be accurate and legible. The records should include the following:

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

A file of names, signatures, and initials for future identification of the individual who signed or initialed a record should be maintained, as needed, with the record or by the radiological control organization.

Unless otherwise specified, radiological control records shall use the special units of curie, roentgen, rad, and rem, including multiples of these units, or other conventional units such as dpm, dpm/100 cm^2. Use of the international system of units should be limited to calculational, scientific, or reference purposes.

Medical Records

Pre-employment medical records, if available and reports of periodic medical examinations should be maintained.

Physical examination reports and fit testing results for respirator use should be maintained for respirator users.

Medical evaluations and treatment performed in support of the radiological control program should be documented.

Radiological Training and Qualification Records

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

Formal records or summary reports of training and qualification should be readily available to first-line supervision and management of involved personnel to aid in making work assignments.

Radiological Control Procedures

Policies, Procedures, and Radiological Work Permits

Records of the radiological control program should consist of policy statements, procedures, work authorizations, and supporting data. The records should be maintained in a manner that will allow correlation with the corresponding support information. For example, procedures for performing radiation surveys should be identifiable with the survey results. Completed radiological work permits should be maintained.

Physical Protection of Records

Methods for protecting documents should include vaults, file rooms with fixed fire suppression, fire rated cabinets, duplicate storage, or combinations of these.

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

Records should, as a minimum, be protected from:

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

Note: You do not have to do example 2 on the following page, but it is a good time to check your skill and knowledge of the information covered. You may do the example 1 or go to the practice.

EXAMPLE 2

1. Under what conditions does a non-uniform radiation field exist?

2. What topics should be covered in a radiological orientation for members of the public who visit DOE facilities where the potential for exposure to radiation exists?

3. What type of documents should be included as radiological controls records?

Note: When you are finished, compare your answers to those contained in example 2 self-check. When you are satisfied with your answers, go on to the practice.

EXAMPLE 2 SELF-CHECK

1. Under what conditions does a non-uniform radiation field exist?
   Non-uniform radiation fields exist when the dose to a portion of the whole body will exceed the dose to the primary dosimeter by more than 50 percent and the anticipated whole body dose is greater than 100 millirem.

2. What topics should be covered in a radiological orientation for members of the public who visit DOE facilities where the potential for exposure to radiation exists?
   The radiological orientation for members of the public should include the following topics:
   - Risk of low-level occupational radiation exposure, including cancer and genetic effects
   - Risk of prenatal radiation exposure
   - Member of the public and management responsibilities for radiation safety
   - Adherence to radiological posting and labeling
   - Applicable emergency procedures
   - Training for issuance of dosimeters, where applicable

3. What type of documents should be included as radiological controls records?
   Radiological control records should include the following:
   - Identification of the facility, specific location, function, and process
   - Signature or other identifying code of the preparer and date
   - Legible entries in ink
   - Corrections identified by a single line-out, initialed and dated
   - Supervisory signature to ensure review and proper completion of forms

PRACTICE

This practice is required if your proficiency is to be verified at the familiar level. The practice will prepare you for the criterion test. You will need to refer to the Order and resources to answer the questions in the practice correctly. The practice and criterion test will also challenge additional analytical skills that you have acquired in other formal and on-the-job training.

1. What is the purpose of DOE-STD-1098-2008?

2. To which DOE position is the authority and responsibility to establish a comprehensive and effective radiological control training program assigned?

3. What is the definition of the term "total effective dose?"

4. What is the definition of the term "lifetime control level?"

5. What are three trigger levels that require a formal radiological review of work activities?

6. What are three planning activities that should be conducted prior to beginning radioactive processes that are conducted infrequently or for the first time?

7. What are three methods used to minimize the volume of mixed waste generated?

8. What are three reasons for evaluating radioactive drains?

9. Which individuals in a DOE facility should be provided personnel dosimetry?

10. What are three requirements for external dosimetry programs?

11. In what areas are area radiation monitors allowed in lieu of personnel dosimeters?

12. What actions should be taken if intakes of radioactive material are indicated that could result in an individual receiving a committed effective dose greater than 100 millirem?

13. What two elements must be included in general employee radiation training?

14. How can a worker challenge radiological worker I or II knowledge requirements?

15. What type of documents should be included in radiological control records?

Note: The course manager will check your practice and verify your success at the familiar level. When you have successfully completed this practice, go to the general level module.

DOE-STD-1073-2003
CONFIGURATION MANAGEMENT
GENERAL LEVEL

OBJECTIVES

Given the familiar level of this module, a scenario, and an analysis, you will be able to answer the following questions:

1. What are the key elements you would look for in the contractor's action plan to correct the situation described in the scenario?
2. Which requirements, sections, or elements of DOE-STD-1073-2003 apply to the situation described in the scenario?

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or the examples, complete the practice now. The course manager will check your work. You will need to complete the practice in this level successfully before taking the criterion test.

RESOURCES

DOE Orders Self-Study Program, DOE-STD-1073-2003, Familiar Level. July 2011.

INTRODUCTION

The familiar level of this module introduced the objectives and basic requirements of DOE-STD-1073-2003. In the general level of this module, students are asked to apply the information contained in the familiar level and the standard to a scenario related to the standard. Each scenario will include a situation, the actions taken to remedy the situation, and the requirements related to the situation. Students will be asked to review the contractor's actions and decide if they are correct. Students will also be asked to decide if the correct DOE requirements were cited in each situation. Please refer to the standard to make your analysis and answer the questions. You are not required to complete the example. However, doing so will help prepare you for the practice and criterion test.

Note: You do not have to do the example on the following page, but it is a good time to check your skill and knowledge of the information covered. You may do the example or go on to the practice.

EXAMPLE SCENARIO

Please review the following scenario, and then answer these questions.

1. Is the contractor's action plan correct? If not, state what should have been done.
2. Were the correct DOE documents or requirements cited? If not, state the correct documents or requirements.

Scenario

Three electricians were performing work in a high-voltage electrical vault. As the electrician placed a wrench near a bolt to remove the links off of the power side of a circuit interrupter, he heard a buzz and felt a tingling. He immediately released the wrench. The wrench arced as it contacted the cabinet. Power was lost to buildings fed by the feeder that had shorted out.

An investigation of the event revealed the following:

- The electrical worker failed to perform an absence-of-voltage check prior to starting work.
- The work control process does not impose requirements to develop specific controls for critical steps when activities are classified as minor maintenance.
- The work controls contain work codes and wording that allows use of "equivalent" practices.
- The procedures for electrical isolation have not been revised to reflect the current power system distribution. Redline drawings of the current power system configuration are not being maintained up-to-date.
- Use of a single minor maintenance work package for the entire scope of the modification did not meet the requirements.

The contractor's action plan included the following:
Immediate actions

- Electrical work being performed in this building was stopped.
- A safe condition was established.
- Worker was taken to medical and confirmed no injuries.
- Power was restored to the buildings that lost power.

Corrective actions

- The work packages for power distribution will contain controls for identifying the proper location or component to be worked on.
- No work will be performed until a zero energy check is performed at the nearest point where the work is to be conducted.
- High voltage work will be performed using a work package that is developed for that scope of work.

DOE requirements that apply to this scenario include the following:

- To ensure that work is appropriately evaluated and coordinated before it is performed, contractors must incorporate a work control process into their procedures. Work control is an administrative process by which work activities are identified, initiated, planned,

scheduled, coordinated, performed, approved, validated and reviewed for adequacy and completeness, and documented. Work control processes should ensure that when work activities are performed, consistency is maintained between the documents, the procedures, and the physical configuration of the nuclear facility. (DOE-STD-1073-2003. page 4.1)

- Contractors must establish and use a formal change control process as part of the configuration management process. The objective of change control is to maintain consistency among design requirements, the physical configuration, and the related facility documentation, even as changes are made. The change control process is used to ensure changes are properly reviewed and coordinated across the various organizations and personnel responsible for activities and programs at the nuclear facility. (DOE-STD-1073-2003, page 5-1)
- The change control process must include provisions for the initiator of the proposed change to document the proposed change. (DOE-STD-1073-2003, page 5-5)
- The change control process must contain provisions for a formal, multidisciplinary technical review to be performed for proposed changes to assess the impacts of the proposed changes to the facility, activity, or operation. (DOE-STD-1073-2003, page 5-6)

Take some time to review the example scenario and the actions the contractor took to correct the situation. Then decide if the contractor's actions were complete and correct. Finally, determine if the requirements, sections, or elements of DOE O 458.1 that were cited in this scenario are correct.

Write your answers below and then compare your answer to the one contained in the example self-check.

EXAMPLE SELF-CHECK

Your answer does not have to match the following exactly. You may have added more corrective actions or cited other requirements from the standard that apply. To be considered correct, you answer must include, at least the following.

All of the actions taken in this situation were appropriate. One additional action should have been taken.

- A work pause should have been called for all electrical work on high voltage equipment.

The correct requirements are cited.

PRACTICE

This practice is required if your proficiency is to be verified at the general level. The practice will prepare you for the criterion test. You will need to refer to the standard and the resources to answer the questions in the practice correctly. The practice and criterion test will also challenge additional analytical skills that you have acquired in other formal and on-the-job training for the facility representative position.

Please review the following scenario and answer the following questions.

1. Was the situation handled correctly? If not, what should have been done?
2. Was the list of requirements, sections, and elements complete and correct? If not, state the correct or omitted requirements.

Scenario

A construction oiler performing crane boom cable lubrication on a 225-ton mobile crane received a severe injury to the left hand that was pulled into a sheave pinch point.

Lubrication of the cable was performed by wrapping a lubricant soaked rag around the crane cable and holding the rag in place with the oiler's gloved left hand. Additional lubricant was applied to the cable and rag during the operation by pouring gear oil with the oiler's right hand. The cable lubrication was first conducted by slowly lowering the crane boom to allow crane cable travel while lubricant was applied. During this downward movement of the boom the cable is moving away from the adjacent sheave and pinch point.

After the crane boom was in the full down position the crane operator and oiler stopped and discussed transitioning to moving the crane boom back up to complete cable lubrication.

Shortly after moving the crane boom in the upward direction the oiler yelled to "boom down." The crane operator lowered the boom and then responded to the oiler's location outside the crane cab. The oiler told the crane operator that the lubricating rag caught on the cable and pulled his hand into the sheave. The action of booming down reversed the cable direction and had apparently released the oiler's hand.

The safety representative, the onsite emergency coordinator, and the operation center were immediately notified. The operation center dispatched an ambulance and the injured worker was transported to an area hospital where the worker was admitted. The injury caused severe damage to several fingers on his left hand requiring immediate medical treatment and subsequent surgery.

This accident resulted in the loss of three fingers and skin grafts for the oiler's left hand.

An investigation of the incident revealed the following:

- Roles and responsibilities for crane maintenance activities were not clearly defined.
- Crane maintenance activities were not identified in the applicable work package.

- The hand swabbing lubrication method with a moving wire rope was performed numerous times prior to the event yet it was never identified that the lubrication activity was not documented in the work package.
- The work package was not reviewed and the safe work brief checklist questions were not fully addressed.
- The safe work brief was deficient in that a worksite walkdown was not performed.

The contractor's action plan included the following:
Immediate actions

- The construction manager conducted a safety stand-down.
- Pending the results of the critique and initial investigation, all non-automatic cable lubrication was suspended.

Corrective actions

- Define the work steps with sufficient clarity, detail, and completeness to support the job hazard analysis.
- Ensure that the identified hazards are either removed or controlled.
- Existing and active work packages will be reviewed against the revised criteria.

The contractor concluded that DOE-STD-1073-2003 does not apply to this scenario as configuration management does not appear to be an issue in this case.

Write your answers to questions 1 and 2 below and on the next page and then bring the completed practice to the course manager for review.

Note: The course manager will check your practice and verify your success at the general level. When you have successfully completed this practice, the course manager will give you the criterion test.