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

DOE O 458.1

RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

DOE O 458.1
RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT
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 are the objectives of DOE O 458.1?
2. What are the definitions for the following terms?
   - Residual radioactive material
   - Public dose
   - ALARA
   - Soil column (in the context of radiation protection of the environment)
3. What are three basic considerations that should be observed in an ALARA process for DOE radioactive activities?
4. What are four elements that must be included in dose evaluations to demonstrate compliance with the public dose limit?
5. What is the purpose for environmental monitoring at a DOE radiological activity?

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.
40 CFR 141, "National Primary Drinking Water Regulations." July 1, 2010.
40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings." July 1, 2010.
Atomic Energy Act. 1954.
DOE O 458.1, chg. 2, *Radiation Protection of the Public and the Environment.* 6/6/11.
DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota.* July 2002.

INTRODUCTION

The familiar level of this module is divided into two sections. In the first section, we will discuss the objectives and definitions related to the Order. In the second section, we will discuss the requirements in section four of the Order and the responsibilities of the field element managers for compliance with DOE O 458.1. We have provided examples and practices throughout 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 O 458.1. Copies of the Orders are available at https://www.directives.doe.gov/ 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, OBJECTIVES AND DEFINITIONS

Objectives

The objectives of DOE O 458.1 are

- to conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits;
- to control the radiological clearance of DOE real and personal property;
- to ensure that potential radiation exposures to members of the public are as low as reasonably achievable (ALARA);
- to ensure that DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public;
- to provide protection of the environment from the effects of radiation and radioactive material.

Definitions

As Low As Reasonably Achievable (ALARA)
An approach to radiation protection to manage and control releases of radioactive material to the environment, and exposure to the work force and to members of the public so that the levels are as low as is reasonably achievable, taking into account societal, environmental, technical, economic, and public policy considerations. As used in DOE O 458.1, ALARA is not a specific release or dose limit but a process which has the goal of optimizing control and management of releases of radioactive material to the environment and doses so that they are as far below the applicable limits as reasonably achievable.

Derived Concentration Technical Standard (DCS)
A DCS is a DOE technical standard that documents the derived concentration value for a radionuclide in water that would result in a dose of 100 mrem in a year to a gender- and age-weighted reference person using DOE approved dose conversion factors and assuming continuous exposure.

Public Dose
The dose received by members of the public from exposure to radiation and to radioactive material released by a DOE radiological activity whether the exposure is within a DOE site boundary or offsite.

Residual Radioactive Material
Any radioactive material which is in or on soil, air, water, equipment, or structures as a consequence of past operations or activities of the Department or its predecessors.

Soil Column
An in situ volume of soil through which liquid waste streams percolate from ponds, cribs, trenches, drain fields, or other areas or facilities used for the primary purpose of removing or retaining the suspended or dissolved radionuclides.

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

EXAMPLE 1

Using the familiar level of this module and the resources, answer the following questions.

1. What are the objectives of DOE O 458.1?

2. What is the definition for the following terms?
   - Residual radioactive material
   - Public dose

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

EXAMPLE 1 SELF-CHECK

1. What are the objectives of DOE O 458.1?
   The objectives of DOE O 458.1 are
   - to conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits;
   - to control the radiological clearance of DOE real and personal property;
   - to ensure that potential radiation exposures to members of the public are as low as reasonably achievable (ALARA);
   - to ensure that DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public;
   - to provide protection of the environment from the effects of radiation and radioactive material.

2. What is the definition for the following terms?
   - Residual radioactive material
   - Public dose

   Residual radioactive material
   Any radioactive material which is in or on soil, air, water, equipment, or structures as a consequence of past operations or activities of the Department or its predecessors.

   Public dose
   The dose received by members of the public from exposure to radiation and to radioactive material released by a DOE radiological activity whether the exposure is within a DOE site boundary or offsite.

SECTION 2, REQUIREMENTS AND RESPONSIBILITIES

This section summarizes the requirements contained in section four of the Order. For a detailed description of all of the requirements please refer to the Order. Additionally, this section also includes the responsibilities of the field element managers for radiological protection.

Environmental Radiological Protection Program

DOE must ensure the following:

- DOE or DOE contractors operating sites or implementing projects, involving radiological activities that can affect the public or environment, must establish and maintain a program that complies with applicable requirements.
- The program, which is the composite of plans, procedures, protocols, and other documents describing the methods used to achieve compliance, must be tailored to the hazard or risk and particular radiological activities being conducted at the site and relevant requirements.
- For any determination that a requirement of DOE O 458.1 is not relevant, the basis for that determination is appropriate to the hazard and adequately documented.

DOE must document directions to the contractor necessary to correct any potential inadequacies or inappropriate determinations of relevancy.

DOE must ensure that long-term stewardship and institutional controls for protection of the public and environment determined necessary to meet the requirements of DOE O 458.1 are adequately documented and implemented as long as is necessary.

Public Dose Limit

DOE radiological activities, including remedial actions and activities using technologically enhanced naturally occurring radioactive material (TENORM), must be conducted so that exposure of members of the public to ionizing radiation will

- not cause a total effective dose (TED) exceeding 100 mrem (1mSv) in a year, an equivalent dose to the lens of the eye exceeding 1500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5000 mrem (50 mSv) in a year, from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose with certain exceptions; and
- comply with ALARA requirements in DOE O 458.1.

The public dose limit applies to members of the public located off DOE sites and on DOE sites outside of controlled areas, and to those exposed to residual radioactive material subsequent to any remedial action or clearance of property.

Temporary Dose Limits

Special circumstances could affect a DOE radiological activity in such a manner that the potential dose to a member of the public could exceed a TED of 100 mrem (1 mSv) in a year.

The field element manager may request specific authorization for a temporary public dose limit higher than 100 mrem (1 mSv) in a year from a cognizant secretarial officer (CSO) in consultation with the Chief Health, Safety And Security Officer. This request must include documentation that justifies the need for the increase, the alternatives considered, and the application of the ALARA process.

A CSO must limit approval of such requests to no more than 500 mrem (5 mSv) TED, provided that the average TED over any 5 contiguous years does not exceed 100 mrem per year.

As Low As Reasonably Achievable

A documented ALARA process must be implemented to optimize control and management of radiological activities so that doses to members of the public and releases to the environment are kept as low as is reasonably achievable. The process must be applied to the design or modification of facilities and conduct of activities that expose the public or the environment to radiation or radioactive material.

The ALARA process must: consider DOE sources, modes of exposure, and all pathways that potentially could result in the release of radioactive materials into the environment, or exposure to the public; use a graded approach; and to the extent practical and when appropriate, be coordinated with the 10 CFR 835, "Occupational Radiation Protection."

The ALARA process must be applied to all routine radiological activities. Though not applicable to non-routine radiological events, the ALARA process is applicable during recovery and remediation activities associated with a non-routine event.

Demonstrating Compliance with the Public Dose Limit

Dose evaluations to demonstrate compliance with the public dose limit and to assess collective dose must include the following:

- The TED to members of the public from exposure to radiation, airborne effluents, and liquid effluents, of DOE origin
- Analytical models that consider likely exposure pathways
- The dose to members of the public from DOE-related exposure sources only, if the projected DOE-related dose to the representative person or maximally exposed individual (MEI) is 25 mrem (0.25mSv) in a year or less
- Collective dose for members of the public resulting from radiation emitted and radioactive materials released from DOE radiological activities only

The estimated individual dose to the MEI or representative person that is representative of the persons or group likely to receive the most dose is based on pathway and exposure parameters that are not likely to underestimate or substantially overestimate the dose, and, the collective dose is a realistic as practicable estimate of the sum of the doses to all members of the actual exposed population.

Site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of DOE radiological activities, land use, food supplies, and exposure pathway information must be updated, as necessary, to document significant changes that could affect dose evaluations.

Values of assumed default or site-specific parameters used in calculations must be identified and included with the documentation of the calculations.

Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.

Dose evaluation models that are codified or approved for use by DOE must be used.

DOE-approved dose coefficients must be used to evaluate doses resulting from DOE radiological activities.

Doses to members of the public from airborne effluents must be evaluated with the CAP-88 model or another EPA-approved model or method to demonstrate compliance.

Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate the dispersal pattern in the environs, characterize the pathway(s) of exposure to members of the public, and estimate the doses to individuals and populations in the vicinity of the site or operation.

Site-specific environmental monitoring criteria must be established to ensure that representative measurements of quantities and concentrations of radiological contaminants are conducted and that the effects from DOE radiological activities on members of the public and the environment are monitored sufficiently to demonstrate compliance.

Airborne Radioactive Effluents

Radiological activities must be conducted in a manner such that the release of radioactive material to the atmosphere will

- be evaluated using the ALARA process;
- not cause radon-222 flux rates to exceed 20 pCi (0.7 Bq) m-2 sec-1 averaged over the surface area overlaying waste, including the covering or other confinement structures, wherever radium-226 wastes are accepted for storage or disposal;
- meet compliance agreements;
- not cause the radon-220 and radon-222 decay product concentration, including background, to exceed 0.03 WL in buildings that are being released from DOE control;
- not exceed 3 pCi/L annual average radon-220 and radon-222 concentration, not including background, at the site boundary if DOE activities release radon-220 and radon-222 or their decay products.

Control and Management of Radionuclides from DOE Activities in Liquid Discharges

Operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities must do the following:

- Characterize planned and unplanned releases of liquids containing radionuclides from DOE activities, consistent with the potential for on and offsite impacts, and provide an assessment of radiological consequences as necessary to demonstrate compliance.
- Comply with the ALARA process.
- Conduct activities to ensure that liquid releases containing radionuclides from DOE activities are managed in a manner that protects groundwater resources now and in the future.
- Conduct activities to ensure that liquid discharges containing radionuclides from DOE activities do not exceed an annual average of either 5 pCi (0.2 Bq) per gram above background of settleable solids for alpha-emitting radionuclides or 50 pCi (2 Bq) per gram above background of settleable solids for beta-emitting radionuclides.
- Except for tritium and sanitary sewers, apply best available technology (BAT).
- Control releases of tritium in a manner that has been established by application of the ALARA process.
- Conduct radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contamination limits.
- Prohibit the use of soil columns.
- Manage the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and groundwater and prevent the creation of future cleanup sites.
- Ensure that storm water runoff containing radionuclides from DOE activities is considered, as appropriate, as a pathway of exposure that has the potential for on and offsite impacts.

Radioactive Waste and Spent Nuclear Fuel

Radiological activities must be conducted in a manner such that radiation exposure to members of the public from management and storage of radioactive waste complies with ALARA process requirements and does not result in a TED greater than 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.

DOE management of spent nuclear fuel, and high-level and transuranic wastes at a disposal facility which is not regulated by the Nuclear Regulatory Commission (NRC) must comply with the requirements.

Management, storage and disposal of low-level radioactive waste must be conducted in a manner such that exposure to members of the public to radiation from radioactive waste complies with ALARA process requirements, and does not exceed a TED of 25 mrem (0.25 mSv) in a year from

all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.

Management, storage and disposal of 11e.(2) byproduct material, as defined in section 11e.(2) of the Atomic Energy Act and other wastes containing uranium and thorium and their decay products which are not subject to the requirements of 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," are not at facilities licensed by the NRC, or are not disposed of at DOE low-level waste disposal facilities, must be in accordance with the requirements of DOE O 458.1 and DOE-approved plans.

Protection of Drinking Water and Groundwater

DOE sites must provide a level of radiation protection for persons consuming water from a drinking water system operated by DOE, directly or through a DOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR 141, "National Primary Drinking Water Regulations."

Groundwater must be protected from radiological contamination to ensure compliance with dose limits in DOE O 458.1 and consistent with ALARA process requirements.

Protection of Biota

Radiological activities that have the potential to impact the environment must be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations.

When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota then evaluations must be done to demonstrate compliance in one or more of the following ways:

- Use DOE-STD-1153-2002, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota.
- Use an alternative approach to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2002.
- Use an ecological risk assessment to demonstrate that radiation and radioactive material released from DOE operations will not adversely affect populations within the ecosystem.

Release and Clearance of Property

Release or clearance of property with the potential to contain residual radioactive material must be conducted in accordance with the requirements of DOE O 458.1

Property control and clearance processes must be developed and implemented in accordance with the dose limits under any plausible use of the property and the ALARA process requirements in DOE O 458.1 must be met before property is cleared.

Unless alternative dose constraints are approved by issuance of a directive or memorandum by the Chief Health, Safety and Security Officer or for NNSA, the CSO in consultation with the Chief Health, Safety and Security Officer, the following dose constraints for DOE residual radioactive material must be applied to each specific clearance of property for any actual or likely future use of the property:

- Real property—a TED of 25 mrem (0.25 mSv) above background in any calendar year
- Personal property—a TED of 1 mrem (0.01 mSv) above background in any calendar year

Property potentially containing residual radioactive material must not be cleared from DOE control unless either the property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or the property is evaluated and appropriately monitored or surveyed.

Real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls or impacting long-term stewardship of adjacent DOE real property.

Organizations responsible for radiological clearance of property, when they rely in part, on process knowledge as a basis for clearance decisions, must establish a documented evaluation process, using a graded approach, for applying process and historical knowledge to determine if property potentially contains residual radioactive material.

Authorized limits must be established and approved for the clearance of any property with residual radioactive material to provide reasonable assurance that the requirements of DOE O 458.1 are met. Authorized limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive material but in which no residual radioactive material can be detected. All authorized limits must be approved in writing by the field element manager. If established authorized limits are found to be not protective, appropriate or practical to apply for a specific type or portion of property, further clearance for that specific type or portion of property must not proceed without revised authorized limits.

Clearance of property with residual radioactive material from environmental restoration activities, including deactivation and decommissioning, must meet the requirements of DOE O 458.1.

All radiological monitoring or surveys performed in support of clearance of property must

- use methodologies sufficient to meet measurement objectives such as those in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), the Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME) or other methodologies approved by DOE;
- meet measurement quality objectives;
- use DOE-approved sampling and analysis techniques, if applicable; and
- include an evaluation of non-uniformly distributed residual radioactive material, if applicable.

Instrumentation used for radiological monitoring or surveys must be capable of detecting and quantifying residual radioactive material consistent with the applicable authorized limits, and be

- periodically maintained and calibrated on an established frequency;
- appropriate for the type(s), levels, and energies of the radiation(s) encountered; and
- appropriate for existing environmental conditions and routinely tested for operability.

DOE elements responsible for radiological clearance of property must ensure that final radiological monitoring or surveys are conducted and that documentation is prepared that shows that the clearance meets applicable DOE authorized limits.

DOE field element managers responsible for oversight of clearance processes must implement oversight duties to verify that the contractor assurance program is ensuring that the applicable radiological clearance requirements have been met. DOE must determine the type and scope of oversight activities necessary to independently verify compliance. Such oversight must use a graded approach commensurate with the Department's requirements to implement DOE oversight functions.

Field element managers must, as appropriate, incorporate information on site clearance policies and protocols, process knowledge decisions, approved authorized limits and property control and clearance programs into effective site public notification and communications programs.

Clearance of property must be documented. The contents of the documentation or the mechanism for documenting information may be tailored to the need, situation, and type of property being cleared. For ongoing, routine clearances such documentation may be based on the general process rather than each specific clearance. In general, the documentation must describe the clearance process and the property being cleared.

Records, Retention and Reporting Requirements

Required records include the following:

- Information and data necessary to identify and characterize releases of radioactive material to the environment, their fate in the environment, and their probable impact on radiation dose to members of the public, and any impacts on ecological systems
- Documentation of individual and collective dose to members of the public due to radiological activities
- Requests for specific authorization for temporary public dose limits, and subsequent approvals and other related actions
- Identification of radiological activities subject to environmental radiological protection program requirements, and descriptions of the measures to be used in implementing these requirements
- Documentation of actions taken to implement the ALARA process
- Documentation of actions taken to demonstrate compliance with the public dose limit

- Documentation of actions taken to implement the BAT selection process in regulating liquid discharges, including documentation of analyses and factors considered to be important, including alternative processes, for the BAT selection process
- Effluent monitoring and environmental surveillance information and data
- Documentation related to the long-term management of radioactive waste and residual radioactive material
- Final documentation for clearance of property containing residual radioactive material

Field Element Manager Responsibilities

Implement the requirements in DOE O 458.1 for radiological activities under their purview. Such implementation must include the following:

- Environmental radiological protection programs are established and maintained.
- Reviews of the site's effectiveness in implementing the requirements in DOE O 458.1 are conducted.
- All required records, reports, and documentation are prepared, issued, and/or retained in accordance with applicable requirements.

Approve applicable authorized limits for clearance of property in accordance with the requirements.

Ensure that the site's annual budget requests include the funding and resources needed to implement the requirements of DOE O 458.1.

Determine the type and scope of oversight activities necessary to independently verify compliance and implement the site independent verification activities.

Ensure that appropriate capabilities are maintained for monitoring and assessing routine and unplanned releases of radioactive materials, consistent with the types of radioactive materials released, release modes, and radiological activities conducted.

Ensure that agreements, permits, leases, licenses, or other legally binding obligations between DOE and a tenant or concessionaire entered into after the effective date of DOE O 458.1, require that the tenant or concessionaire take actions relating to matters within the scope of the contract that facilitate DOE's compliance.

Temporarily suspend any requirement when doing so is in their judgment necessary to minimize damage to life or property or to protect public health or safety. Whenever this provision is invoked, such suspension and the reason for it are to be reported to a CSO and to the Chief Health, Safety and Security Officer at the earliest practicable time.

Approve use of an alternative approach capable of demonstrating the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2002, table 2.2.

Ensure survey methods and modeling are adequate to meet the requirements, and consult with the Office of Health, Safety, and Security as necessary.

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 2 or go directly to the practice.

EXAMPLE 2

1. What are the public dose limits for DOE radiological activities?

2. What is the process for the field element manager to request a temporary dose limit higher than 100 mrem?

3. To what activities must the ALARA process be applied to be in compliance with DOE O 458.1?

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. What are the public dose limits for DOE radiological activities?
   DOE radiological activities must be conducted so that exposure of members of the public to ionizing radiation will
   - not cause a TED exceeding 100 mrem (1mSv) in a year, an equivalent dose to the lens of the eye exceeding 1500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5000 mrem (50 mSv) in a year, from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose with certain exceptions; and
   - comply with ALARA requirements in DOE O 458.1.

2. What is the process for the field element manager to request a temporary dose limit higher than 100 mrem?
   The field element manager may request specific authorization for a temporary public dose limit higher than 100 mrem in a year from a cognizant secretarial officer in consultation with the Chief Health, Safety and Security Officer. This request must include documentation that justifies the need for the increase, the alternatives considered, and the application of the ALARA process.

3. To what activities must the ALARA process be applied to be in compliance with DOE O 458.1?
   The ALARA process must be applied to all routine radiological activities.

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 are the definitions for the following terms?
   - ALARA
   - Soil column

2. To what specific members of the public do the public dose limits apply?

3. What are three basic considerations that should be observed in an ALARA process for DOE radioactive activities?

4. What are four elements that must be included in dose evaluations to demonstrate compliance with the public dose limit?

5. What is the purpose for environmental monitoring at a DOE radiological activity?

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 O 458.1
RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT
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 O 458.1 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 O 458.1, Familiar Level. July 2011.
10 CFR 835, "Occupational Radiation Protection." January 1, 2011.
40 CFR 141, "National Primary Drinking Water Regulations." July 1, 2010.
40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings." July 1, 2010.
Atomic Energy Act. 1954.
DOE O 458.1, chg. 2, *Radiation Protection of the Public and the Environment.* June 6, 2011.
DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota.* July 2002.

INTRODUCTION

The familiar level of this module introduced the objectives of DOE O 458.1 Several definitions and the requirements associated with the Order were discussed. In the general level of this module, students are asked to apply the information contained in the familiar level and the Order to a scenario. 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 Order 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

On February 27, 2006, facility management was notified that a radiological control technician (RCT) had detected two spots of alpha contamination on the personal clothing of a laboratory employee while the employee was at his home. The contamination measured 1,200 disintegrations per minute (dpm) on the heel of the employee's shoe and 300 dpm on the employee's right pant leg. The contaminant on the employee's shoe was plutonium-239. The contaminants on the employee's pants were isotopes of uranium.

Following the discovery of the contamination, the RCT removed and properly packaged the contaminated clothing. No other contamination was detected on the employee. Extensive surveys were performed in the employee's home and automobile, and in areas where the employee had been since leaving work before the discovery of the personal contamination. No activity was detected. The employee also submitted nasal smears. Results were no detectable activity.

Background

In the morning of February 27, 2006, four employees began work on process equipment. The equipment is used to perform vacuum transfers of uranium hexafluoride from research containers to laboratory-approved storage vessels or Department of Transportation-approved shipping containers. The work performed by the employees involved the replacement of the vacuum pump associated with the transfer equipment. Because the pump and its internals are known to be contaminated with isotopes of uranium, the work was performed in a radiological hood.

At approximately 15:30, E2 prepared to exit the buffer area by removing his lab coat and gloves and then washing his hands in an approved sink. E2 then exited the room and self-monitored his booties and bare hands with a hand and foot monitor located just outside the room's exit. When E2 monitored his booties, the instrument alarmed, indicating the presence of contamination on the bottom of one of his booties. E2 then removed both booties and put on a clean pair of booties. After putting on the clean booties, E2 placed the contaminated bootie in a plastic bag and placed the bag inside the room. E2 did not contact an RCT when he discovered the contaminated bootie.

After inspecting the equipment, E2 prepared to exit the buffer area. At the buffer area exit, E2 self-monitored with an HFM- 7 instrument. The instrument alarmed, indicating the presence of alpha contamination on both of his hands. E2 then self-monitored a second time. The instrument did not alarm. RCTs in the area heard the first alarm and responded as E2 performed the second self-monitor. Under RCT supervision, E2 then exited the buffer area, removed his labcoat and booties, exited the controlled area, and self-monitored just outside the exit of the controlled area. The

instrument alarmed, indicating the presence of contamination on E2's left hand. One of the RCTs then performed alpha and beta surveys of E2's hand. The RCT verified 300 dpm of alpha contamination in a localized spot on E2's hand. Due to relatively high background in the area, the beta survey was inconclusive. The RCT also contacted his health physics operations supervision. The time was approximately 16:00.

The RCT supervisor then had E2 self-monitor. E2 was then escorted to a unit for additional whole-body monitoring. Results of the survey were negative. E2 then self-monitored. Results were negative.

Immediately after the alarm, an RCT sent by the RCT supervisor to escort E1 to wing 5 arrived. E1 told the RCT that the instrument had alarmed. The RCT then escorted E1 to wing 5 where E1 self-monitored. No activity was detected. The RCT then had E1 self-monitor with another HFM-7 instrument in wing 5. The instrument alarmed, indicating the presence of contamination on both of E1's hands. The RCT had E1 self-monitor a second time with the HFM-7. The instrument alarmed again, indicating the presence of contamination on E1's right hand. The RCT then surveyed E1's hands with an NE-Tech. The RCT verified alpha contamination measuring from 1,700 to 2,300 dpm in localized spots on the palms of E1's hands. The RCT supervisor, who had just arrived in wing 5 with E2, told the RCT to escort E1 to a controlled area for decontamination of E1's hands.

Unaware of the initial personal contamination incident in wing 9, E3 had gone home at approximately 16:00. E4 attempted to contact E3 at his home at 16:30 and again at 17:30, with no answer. The RCT supervisor also repeatedly attempted to contact E3.

When E3 arrived at his house, he noted no one else was home and went to a local barber shop. After getting a hair cut, E3 returned home at 18:00. The RCT supervisor contacted E3 at his home at 18:00 and informed him of the contamination incident and that an RCT was being sent to his home to perform surveys. E3 acknowledged this and sat on his couch to await the RCT.

Upon finding the contamination, the RCT taped over the contamination on E3's pants, had E3 remove his shoe, and then bagged the shoe. The RCT also had E3 submit nasal smears. Results were NDA. The RCT then informed the RCT supervisor of the discovery of the contamination. The RCT supervisor then contacted his ESH-1 team leader. The team leader told the RCT supervisor to contact facility management and recommended that facility management contact the laboratory's emergency management and response (EM&R) team. The RCT supervisor then contacted facility management, who then contacted EM&R.

An investigation of the situation revealed the following:

- During the critique, E3 stated that after he had worked in the room, he removed his lab coat and gloves and washed his hands. He then exited the room and self-monitored his hands and booties. No activity was detected. E3 then exited the controlled area and self-monitored his hands and booties just outside the controlled area. No activity was

detected. E3 then removed and discarded his booties and exited the building via wing 4. E3 did not self-monitor his shoes with the booties off before he exited the building.

- Through isotopic analysis, ESH-1 determined the contaminant on the bottom of E3's shoe to be plutonium-239. The source of the plutonium contamination could not be determined.
- Although the time that E3's shoe became contaminated could not be positively determined, facility management and ESH-1 believe that the shoe contamination occurred sometime after 12:00 on the day of the incident. This belief is based on the fact that no activity was detected on E3's shoes when he last self-monitored in wing 4 at approximately 12:00 on the day of the incident. Had the contamination been present on his shoe at that time, the HFM-7 probably would have detected it. Therefore, at some point after 12:00 on February 29, 2006, E3 unwittingly stepped on a small particle of legacy plutonium-239 contamination.
- In the late afternoon on the day of the incident, E3 exited the controlled area outside the room and then self-monitored with the HFM-7 located in the uncontrolled area at the exit of the wing 5 basement. However, E3 did not follow the policy that required booties to be removed prior to exiting a controlled area and proceeded to self-monitor with the HFM-7 while still wearing his booties. In addition, E3 did not adhere to the posted survey guidelines that also specified that booties were to be removed before self-monitoring with the HFM-7. If the plutonium-239 contamination was present on E3's shoe at this time, had E3 removed his booties as required prior to self-monitoring with the HFM-7, it is probable that the contamination would have been detected and the incident would not have occurred. The failure to remove the booties before self-monitoring with the HFM-7 was therefore determined to be a contributing cause.
- Policy specifies that ESH-1 personnel must be immediately notified when contamination is detected during self-monitoring. E2 did not contact ESH-1 when he discovered his bootie was contaminated during self-monitoring after exiting the room.
- The HFM-7 instrument located in the uncontrolled area at the exit of the wing 5 basement did not detect contamination on the hands of E1 or E2 when they self-monitored with the instrument after exiting the room. However the contamination was later detected on E1's hands with HFM-7 instruments in wings 4 and 5 and on E2's hands in wing 9. A reason the contamination may not have been detected by the first HFM-7 was because the employees' hands were not completely dry when the instrument was used.

The following additional actions were taken in this situation.

- Upon notification, EM&R contacted the team leader for the laboratory's radiological assistance program (RAP). The RAP team leader then contacted the RCT supervisor. After being apprised of the situation, the RAP team leader notified DOE. EM&R also contacted the DOE duty officer. The time was approximately 20:00.
- The RCT (who was still at E3's home), upon instructions from the RCT supervisor, had E3 remove the contaminated pants. The RCT then placed the pants in the bag with the shoe. The RCT then surveyed other clothing worn that day by E3, the furnishings touched by E3, and E3's automobile. No activity was detected. After the surveys, the RCT took

the bag containing the contaminated shoe and pants and went back to the facility. At this time, other ESH-1 personnel were called in to perform isotopic analysis of the contamination on E3's clothing.

- On February 28, 2006, at 10:00, a critique of the occurrence was convened.
- Facility management decided to stand-down programmatic, maintenance, and construction activities on March 1, 2006, to give managers an opportunity to discuss this incident and other radiological control issues with employees. Programmatic, maintenance, and construction activities were temporarily suspended on Friday, March 1, 2006.
- A restatement of the radiological protection policy and employee accountability to that policy was made.
- A review of existing requirements was conducted for adequacy in addressing hazards, too few or too many requirements, and inconsistencies.
- A policy was established that required employees to routinely self-survey with alpha instrumentation during operations that have the potential for contamination and before exiting the room.
- A policy was restated that made the minimum required personal protective equipment for any maintenance performed to be safety goggles, Tyvek coveralls (taped at the wrists), two pairs of gloves, and booties.
- Management trained applicable employees on the procedural modifications.
- ESH-1 provided additional self-monitoring equipment in the room, and then trained applicable personnel in the operation of the new equipment.
- Conducted training that specifies that personnel will allow moist skin to air-dry before self-monitoring.

The following requirements are related to this situation.

- The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem. (DOE O 458.1, page 3)
- The public dose limits apply to doses from exposures to radiation sources from routine activities. (DOE O 458.1, page 4)

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 on the next page 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 Order 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.

- The barber shop should have been surveyed.

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 Order 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

Six boxes containing loaned items from a private collector of historical materials were transported to the National Atomic Museum (NAM). The materials were on loan to the NAM for possible use in a radiological exhibition. The materials were transported to the NAM site using a government vehicle. At the residence of the private collector the items to be loaned were selected, placed into boxes, and then put into the government vehicle. The boxes containing the radioactive materials were not packaged or labeled or transported in accordance with Department requirements.

Knowing that some of the items contained naturally occurring radioactive materials and consumer products with low levels of radioactive materials, the items were placed into a transportainer designated for the NAM storage of radioactive materials. The requirement to store these materials in a posted radioactive materials area and conduct radiation surveys prior to use is part of the NAM policy for determining if materials are suitable for display. These controls prevent materials from being placed in the public and prevent the potential for radiation exposure.

On September 23, 2002, three individuals, including two radiological control technicians (RCTs), began to unpack and inventory the loaned materials to evaluate the radioactivity levels. The unpacking and inventory were conducted in accordance with the requirements of a radiological work permit (RWP) and within an area with established radiological controls. This was done to meet the requirements in the NAM policy for receipt of display materials.

Some of the loaned items were known to contain radioactive materials and they were surveyed and inventoried at the start of the process. The process was continued and after unpacking and inventorying four of the six boxes and finding no additional radioactive materials or unusual radiation levels, the individuals decided to remove the surgeon gloves they had been wearing. While unpacking the next box, several items were found to have radiation levels that required further evaluation. However, they did not put on gloves before handling the materials.

While inspecting one of these items the hands of all three individuals became contaminated. One individual had contamination levels of 9750 dpm beta/gamma activity, the other two individuals contamination levels were much lower. Other RCTs were contacted and decontaminated these

persons' hands within 30 minutes. The exposure to the individuals' hands from the contamination was of such a low magnitude as to constitute no recordable dose. A complete survey of the area was conducted and there was no detectable spread of contamination in the work area. In addition, the vehicle used to transport the materials was surveyed and there was no contamination detected. The materials that caused the contamination were properly packaged and labeled, then placed back into the box, which was then sealed and placed into the transportainer, which was locked. All waste that was generated due to the decontamination efforts was collected and was disposed of in accordance with requirements.

An investigation of the incident revealed the following:

- Gloves were not worn while performing a radiological survey of items from a private collection.
- The inventory of a proposed private collection was not reviewed by the National Atomic Museum Acquisition Review Committee (NAMARC), on which, representatives from radiation protection sit, prior to accepting the private collection. A review of the inventory may have identified potential sources of removable contamination.
- The survey performed by the private collector prior to transport of the collection was inadequate. It failed to identify radioactivity associated with the box containing the radium source.
- The written inventory of the boxes was available prior to the RCT survey. However, the written inventory was not given directly to the RCTs and through a miscommunication between RCTs and NAM staff, it was not reviewed by the RCTs prior to performing the survey.
- The RCTs made the decision to complete the radiological survey without gloves after several boxes of materials had been surveyed. This decision was based on inadequate information communicated about the potential radioactive nature of the items to be surveyed.

Immediate actions taken included the following:

- The hands of the individuals were decontaminated.
- A complete survey of the area was conducted.

Corrective actions included the following:

- Review and modify the policy for acquisition by, or loan to, or being borrowed from, the NAM to address acceptance of radiological surveys performed by non-DOE entities for incoming exhibits prior to taking possession of an exhibit.
- Conduct training for the appropriate NAM and RCT staff on the revisions to the policy.

The DOE requirements that apply to this situation include:

- A documented ALARA process must be implemented to optimize control and management of radiological activities so that doses to members of the public and releases to the environment are kept as low as is reasonably achievable. The process must be

applied to the design or modification of facilities and conduct of activities that expose the public or the environment to radiation or radioactive material.

- The ALARA process must: consider DOE sources, modes of exposure, and all pathways which potentially could result in the release of radioactive materials into the environment, or exposure to the public; use a graded approach; and to the extent practical and when appropriate, be coordinated with the 10 CFR 835 ALARA process. (DOE O 458.1, page 4)

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.