LEARNING OBJECTIVES:

2.08.01 Describe the requirements for radioactive sources as outlined in the DOE Radiological Controls Manual.

☞ 2.08.02 Identify the radioactive sources that must be controlled at your site.

☞ 2.08.03 Identify the packaging, marking, and labeling requirements for radioactive sources.

☞ 2.08.04 Describe the approval and posting requirements for radioactive materials storage areas.

☞ 2.08.05 Describe the procedures used at your site for storage and accountability of radioactive sources.

INTRODUCTION

A radioactive source is material used for its emitted radiation and has a half life greater than 30 days (except tritium). Sources are constructed as sealed or unsealed and are classified as accountable or exempt.

Radioactive sources are used for response checks in the field, functional checks, calibration of instruments and monitors to traceable standards, radiographic sources, soil compaction testing, and moisture/density gauges. To ensure the safety and welfare of all personnel it is important to maintain control of radioactive sources. The purpose of controlling radioactive sources includes:

Minimize potential for

- Spread of contamination
- Unnecessary exposure to personnel
- Loss or theft
- Improper disposal

DOE RADIOLOGICAL CONTROL MANUAL

2.08.01 Describe the requirements for radioactive sources as outlined in the DOE Radiological Controls Manual.

In accordance with the DOE Radiological Control Manual, the following provisions apply to sealed and unsealed sources:

- G-N 5400.9/M1 describes how sealed sources shall be controlled and maintained, and specifies requirements for receipt, inventory, storage, transfer, disposal and integrity testing. Unsealed sources shall be controlled and maintained in a similar manner except for integrity testing.

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

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

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

DOE G-N 5400.9/M1 IMPLEMENTATION GUIDE: SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND CONTROL

This notice was issued in November 1994 and distributed with the series of implementation guides for occupational radiation protection. The IG provides an acceptable methodology for establishing and operating a sealed radioactive source accountability and control program that will comply with U.S. Department of Energy requirements specified in DOE Notice N5400.9, Sealed Radioactive Source Accountability. The IG clarifies the requirements of DOE Notice N 5400.9 and the RCM, and provides guidance for the structure, function, and operation of a sealed radioactive source accountability and control program.

The IG establishes guidelines for custodians, training, receipt, inventory, labeling, storage, use, transfer, survey, test, disposal and records associated with sources.

CONTROL OF SOURCES

2.08.02 Identify the radioactive sources that must be controlled at your site.

(Insert site specific information here)

Types of sources:

- **Accountable Sealed Radioactive Source** - A sealed radioactive source with a half-life greater than or equal to 30 days and an activity greater than or equal to those listed in Appendix B of the IG.

- **Exempted Radioactive Material** - Radioactive materials exempted from accountability under DOE Notice N 5400.9, but subject to the requirements of 10 CFR 835 and DOE Order 5480.11. Exempted radioactive materials include: materials in process, activated shielding materials, liquid and gaseous sources. Materials defined as consumer products (e.g., camera lenses, lantern mantles, smoke detectors, welding rods, etc.) are not subject to these requirements.

- **Exempted Sealed Radioactive Source** - A sealed source having radioactive material with a half-life of less than 30 days or an activity less than the values for various radionuclides listed in Appendix B of the IG.

- **Sealed Radioactive Source** - Radioactive material that is contained in a sealed capsule, sealed between layers of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to use of the radioactive source.

Responsibilities:

- The Radiological Control Organization shall maintain or delegate the responsibility for:

  (1) establishing the program (n5400.9 (6.a))

(2) maintaining records related to the accountability and control of accountable sealed radioactive sources for a facility (N5400.9 (7.a.1&2))

(3) providing each source custodian with an inventory list of accountable sealed radioactive sources assigned to him or her (N5400.9 (7.a.1))

(4) assisting the source custodian in training source users(N5400.9 (7.a.1))

- The source custodian:

(1) shall be responsible for ensuring that tests to establish the integrity of an accountable sealed radioactive source are conducted (N5400.9 (7.b)) and inventory checks are performed at least every 6 months (N 5400.9 (7.b)).

(2) should maintain records of the storage and use locations of all assigned accountable sealed radioactive sources (N 5400.9 (7.a.2)).

(3) shall be trained as a radiological worker prior to being designated as a source custodian.

(4) shall notify and obtain approval of the RCO prior to:

- any major changes in the use of a sealed radioactive source
- on-site transfer of a sealed radioactive source to a new permanent storage location
- modification of a device containing a sealed radioactive source
- disposal or off-site transfer of a sealed radioactive source
- any procurement or acquisition of additional sealed radioactive sources

(5) should also notify the RCO in the event of the loss or damage to any accountable sealed radioactive source

- The source user:

(1) should be an individual trained by the RCO and the source custodian to use either accountable or exempt sealed radioactive sources

(2) should be trained as a radiological worker and receive appropriate training on handling their specific sealed radioactive source(s).

General

- Radioactive sources (solid, liquid, or gas) used exclusively for their emitted radiation and which retain their physical form and configuration during use shall be sealed to prevent the leakage of any radioactive material. Sources such as alpha emitters and special research sources that cannot be covered during use shall have a separate container that encloses the source when not in use.

Sources are controlled using the following precautions:

- Each source is to be inspected before each use.
- Remove damaged sources from service.
- Fingers, whether gloved or not, or other objects should never be allowed to touch the active surface of unsealed sources.
- Protect the source from being contaminated when used in a surface contamination area.

RECEIPT

Prior to receipt of accountable sealed radioactive sources, the RCO should assign the sources to the proper source custodians. Immediately upon receipt of accountable sealed radioactive sources, the RCO should be notified. The packaging should be inspected for damage and a contamination and radiation survey performed. The RCO shall perform receipt surveys (RCM 431.3). A source integrity test shall be performed upon receipt if visible damage to the package exists (N 5400.9 (7.d)), or prior to initial use. The source custodian should be notified of the arrival of the sealed sources to ensure that proper accountability and control are initiated. The sources should be placed into storage or into the device in which they will be used. The source custodian and site's records should be updated to include the new sources received.

LABELING AND STORAGE OF RADIOACTIVE SOURCES

2.08.03 Identify the packaging, marking, and labeling requirements for radioactive sources.

(Insert site specific information here)

Radioactive items or containers of radioactive materials **shall** be individually labeled if adequate warning is not provided by control measures and posting (10 CFR 835.601 (a) and RCM 412.1).

All sealed (accountable and exempt) radioactive sources or their associated storage containers shall be clearly marked as radioactive material with the words "CAUTION, RADIOACTIVE MATERIAL" or the standard radiation symbol (N 5400.9 (7.c.1) and RCM 412). Labels shall have a yellow background with a magenta or black standard radiation symbol. Lettering shall be magenta or black (RCM 412.3). Storage containers and devices containing a radioactive sources shall have a durable label/tag that contains the following information (N 5400.9 (7.c.1)):

- Major radionuclide
- Amount of radioactivity (curie content)
- Date of assay
- Model and serial number
- Source Custodian's name and site telephone extension

In addition, labels should include the contact radiation levels, removable contamination levels, dates surveyed, and surveyor's name (RCM 412.4). The label should be sufficiently durable to remain legible for the useful life of the device or storage container and should be located in a readily visible place.

Accountable sealed sources not in storage containers or devices and not labeled by the manufacturer should be labeled with the following information (N 5400.9 (7.c.2)):

- the words "CAUTION, RADIOACTIVE MATERIAL" or the standard radiation symbol
- radionuclide name
- amount of activity
- date of assay
- name of manufacturer

- model name and serial number

- If the radioactive source is an integral part of a larger piece of equipment, the equipment may be labeled in lieu of the radioactive source itself. Extremely small radioactive sources need a permanent tag attached or be stored in a larger container to prevent the loss of the radioactive source and to allow space for the required markings/identification.

RADIOACTIVE MATERIALS STORAGE AREAS

2.08.04 *Describe the approval and posting requirements for radioactive materials storage areas.*

(Insert site specific information here)

Storage rooms or cabinets containing radioactive sources shall meet all the following requirements:

- Locked and posted
- Located to minimize damage from fire
- Free of flammable substances
- Isolated from occupied areas or located in radiological areas or radiological buffer areas
- When selected in continuously occupied controlled areas, the radiation level at the closest approach is as low as reasonably achievable and does not exceed 0.5 millirem per hour on average
- All radioactive sources with activities greater than the levels posted in DOE 5400.9 must be kept under lock when not in use

Sealed radioactive sources not in storage containers or devices and not labeled by the manufacturer must be clearly marked with a radiation symbol and have a durable label/ tag containing the following information:

- Radionuclide
- Amount of activity
- Name of manufacturer

- Date of assay
- Model and serial numbers (where available)

Gamma radioactive sources (except small counting radioactive sources that are low energy and low activity or well shielded) shall be stored separate from locations where radiation detection/counting equipment is present.

INVENTORY AND TRANSFER

2.08.05 Describe the procedures used at your site for storage and accountability of radioactive sources.

(Insert site specific information here)

All accountable sealed radioactive sources shall be physically checked and their locations verified every six months (N 5400.9 (7.b)). Exempted radioactive material and exempted sealed radioactive sources are not required to be inventoried. Upon determination that an accountable sealed radioactive source has been lost, the RCO should be notified.

An inventory system should provide for tracking accountable sealed radioactive sources. As a minimum, records for accountable sources for a facility shall be organized into a single, comprehensive filing system (N 5400.9 (7.a.2)). The system shall maintain both original and updated information related to accountable sealed radioactive sources (N 5400.9 (7.a.2)), including:

- Major radionuclide
- Curie content or disintegration rate
- Physical and chemical description of the radioactive source
- Manufacturer
- Date of receipt
- Date of assay
- Radioactive source model and serial number (and device containing the radioactive source)
- Inventory check dates
- Transfers

All permanent transfers and disposal(s) of accountable and exempt radioactive sources shall be recorded in the radioactive source logbook by the source user or custodian.

SURVEY

Immediately upon receipt of accountable sealed radioactive sources, the RCO should be notified. The packaging should be inspected for damage and a contamination and radiation survey performed. The RCO shall perform receipt surveys (RCM 431.3). A source integrity test shall be performed upon receipt if visible damage to the package exists (N 5400.9 (7.d)), or prior to initial use.

Storage rooms or cabinets containing either accountable or exempt quantity sealed radioactive sources shall be locked, surveyed routinely, and posted in accordance with N 5400.9 (7.c.1).

Radiation and contamination surveys of sealed radioactive source storage areas or facilities should be performed before its initial use and at least every six months thereafter. Surveys **shall** be performed whenever changes in status are made that may significantly affect radiological conditions (10 CFR 835.401(a)(3), 5480.11, RCM 551.7)

LEAK TEST (INTEGRITY TEST)

A test of source integrity shall be made at least every 6 months or whenever damage might have occurred. The integrity of a sealed source is established by a wipe test and leak test procedures. A wipe test is made on the surrounding surface(s) of the source, except for the active areas. A source contained in a shield or device is checked by wiping the area of the shield or device, where contamination is most likely to occur from a failure of the source integrity. The leak test must be capable of verifying the removable activity is less than 5 nanocuries (nCi) per 100 cm^2. If the activity of the wipe indicates the presence of 5 nCi/100 cm^2 or more of removable contamination, the source will be considered breached and must be removed from service and treated as a nonsealed source.

An integrity test should also be performed when any measurable contamination is detected on handling or storage equipment(unless the contamination is known to be from another source).

An integrity test is not required if the sealed source contains a radionuclide with a half-life of less than 30 days, liquid, or gaseous radionuclide(s), or a radionuclide with an activity smaller than the value listed in Appendix B of the IG. Sealed gaseous radionuclides are exempted from integrity testing because the rapidity with which the gas escapes and diffuses into the air renders the test of little value. Gaseous and liquid sealed radioactive sources should be treated as radioactive materials.

SOURCE DISPOSAL

Obsolete, excess, or leaking accountable sealed radioactive sources should be disposed of according to RCO instructions.

SUMMARY

Sources may be sealed or unsealed and accountable or exempt. Controls for sources is governed by DOE requirements. Responsibility for sources is delineated in contractor procedure. The RCT needs to be knowledgeable of controls to prevent contamination and minimize exposure. All on-site sources require prior written approval. Accountable sources are identified, inventoried, surveyed and tested (sealed only). The use and disposition of sources is maintained on records.

REFERENCES

1. **DOE N 5400.6** (June 1992) "U.S. Department of Energy Radiological Control Manual"

2. **DOE Order 5480.11** (1989) "Radiation Protection for Occupational Workers"

3. Implementation Guide for Occupational Radiation Protection: Sealed Radioactive Source Accountability and Control; G-N 5400.9/M1 - Rev. 1 November 1994

Exempt Quantity Values
Values for Exemption of Sealed Radioactive Sources from Inventory and Itegrity Testing

Less than 300 µCi (1 × 10^7 Bq)							
H-3	Be-7	C-14	S-35	Ca-41	Ca-45	V-49	Mn-53
Fe-55	Ni-59	Ni-63	As-73	Se-79	Rb-87	Tc-99	Pd-107
Cd-113	In-115	Te-123	Cs-135	Ce-141	Gd-152	Tb-157	Tm-171
Ta-180	W-181	W-185	W-188	Re-187	Tl-204		
Less than 30 µCi (1 × 10^6 Bq)							
Cl-36	K-40	Fe-59	Co-57	Se-75	Rb-84	Sr-85	Sr-89
Y-91	Zr-95	Nb-93m	Nb-95	Tc-97m	Ru-103	Ag-105	ln-114m
Sn-113	Sn-119m	Sn-121m	Sn-123	Te-123m	Te-125m	Te-127m	Te-129m
l-125	La-137	Ce-139	Pm-143	Pm-145	Pm-147	Sm-145	Sm-151
Eu-149	Eu-155	Gd-151	Gd-153	Dy-159	Tm-170	Yb-169	Lu-173
Lu-174	Lu-174m	Hf-175	Hf-181	Ta-179	Re-184	Re-186m	lr-192
Pt-193	Au-195	Hg-203	Pb-205	Np-235	Pu-237		
Less than 3 µCi (1 × 10^5 Bq)							
Be-10	Na-22	Al-26	Si-32	Sc-46	Ti-44	Mn-54	Fe-60
Co-56	Co-58	C0-60	Zn-65	Ge-68	Rb-83	Y-88	Zr-88
Zr-93	Nb-94	Mo-93	Tc-95m	Tc-97	Tc-98	Ru-106	Rh-101
Rh-102	Rh-102m	Ag-108m	Ag-110m	Cd-109	Sn-126	Sb-124	Sb-125
Te-121m	l-129	Cs-134	Cs-137	Ba-133	Ce-144	Pm-144	Pm-146
Pm-148m	Eu-148	Eu-150	Eu-152	Eu-154	Gd-146	Tb-158	Tb-160
Ho-166m	Lu-176	Lu-177m	Hf-172	Ta-182	Re-184m	Os-185	Os-194
lr-192m	lr-194m	Hg-194	Pb-202	Bi-207	Bi-210m	Cm-241	
Less than 0.3 µCi (1 × 10^4 Bq)							
Sr-90	Cd-113m	La-138	Hf-178m	Hf-182	Po-210	Ra-226	Ra-228
Pu-241	Bk-249	Es-254					
Less than 0.03 µCi (1 × 10^3 Bq)							
Sm-146	Sm-147	Pb-210	Np-236	Cm-242	Cf-248	Fm-257	Md-258
Less than 0.003 µCi (1 × 10^2 Bq)							
Gd-148	Th-228	Th-230	U-232	U-233	U-234	U-235	U-236
U-238	Np-237	Pu-236	Pu-238	Pu-239	Pu-240	Pu-242	Pu-244
Am-241	Am-242m	Am-243	Cm-243	Cm-244	Cm-245	Cm-246	Cm-247
Bk-247	Cf-249	Cf-250	Cf-251	Cf-252	Cf-254		
Less than 0.0003 µCi (1 × 10^1 Bq)							
Ac-227	Th-229	Th-232	Pa-231	Cm-248	Cm-250		