

GRC Environmental Programs Manual

Chapter 28 – Radiation Protection for Radioactive Materials

NOTE: The current version of this Chapter is maintained and approved by the Environmental Management Office (EMO). The last revision date for this chapter is July 2004. If you are referencing paper copies, please verify that it is the most current version before use. The current version is maintained on the Glenn Research Center intranet at <http://osat-ext.grc.nasa.gov/emo/pub/epm/epm-contents.pdf>. Approved by: EMO Chief, Michael Blotzer {<mailto:Michael.J.Blotzer@grc.nasa.gov>}.

PURPOSE

This chapter describes the policies, procedures, and radiation protection requirements for the receipt, use, storage or transfer of radioactive materials (RAM), or equipment using such materials. The scope of “radioactive material” addressed by this chapter includes the following: radioactive sources/materials covered by U.S. Nuclear Regulatory Commission (NRC) licenses (general, specific, etc.), radioactive sources/materials not regulated by the NRC, and radioactive waste.

APPLICABILITY

The provisions of this chapter are applicable to civil servants, support service contractors (SSC), and construction contractors at NASA Glenn Research Center’s Lewis Field and Plum Brook Station.

DEFINITIONS

ALARA – As Low As Reasonably Achievable

Making a reasonable effort to maintain exposures to radiation as far below the dose limits as is practical (1) consistent with the purpose for which the activity is undertaken, (2) taking into account factors such as available technology and the economics of improvements with respect to their benefits, and (3) in relation to the performance of such activities for the public interest.

Activation

The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear radiations.

Authorized User (AU)

A person whose training and experience have been reviewed and approved by the Nuclear Regulatory Commission (NRC), who is named on the license, and who uses or directly supervises the use of licensed material.

Byproduct Material

(1) Any radioactive material (except *special nuclear material*) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes.

Contamination (Radioactive)

The deposition of unwanted radioactive material on the surfaces of structures, areas, objects or personnel.

Dose, Absorbed

The amount of ionizing radiation energy absorbed in matter, including human tissue. The units of absorbed dose are the rad and the gray (Gy).

Dose, Equivalent

The dose quantity used for radiation-protection purposes that takes into account the different effects observed in tissue for different types of radiation giving the same *absorbed dose*.

Dosimetry

Equipment used for measuring and registering accumulated exposure to ionizing radiation. For the purposes of this chapter, these devices include personal monitoring devices such as thermo-luminescent detectors (TLD), optically-stimulated luminescent detectors (OSL), self-reading dosimeters (SRD), or film badges.

High Radiation Area

An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in any one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Ionizing Radiation

Any radiation (particle or wave) capable of displacing electrons from atoms or molecules, thereby producing ions. Examples: alpha, beta, gamma, x-rays, neutrons, high-speed electrons, protons and other atomic particles

Isotope

One of two or more atoms with the same number of protons, but different number of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, with the numbers denoting the approximate atomic weights. Isotopes have the same chemical properties, but, may exhibit different physical properties (i.e. C-12 and C-13 are stable, whereas C-14 is radioactive).

NARM

Any Naturally-Occurring or Accelerator-Produced Radioactive Material. It does not include byproduct, source, or special nuclear material

NORM

Any Naturally Occurring Radioactive Material. It does not include byproduct, source, or special nuclear material

Non-Occupational Radiation Workers

Individuals who handle radioactive materials on an infrequent basis (Shipping/Receiving personnel), or personnel who may need to enter radiation areas to accomplish tasks that are unrelated to the source of radiation

NRC General License

Authority to possess and use a device containing a radioactive source which is issued by the NRC for devices whose design and intended use satisfy requirements for inherent safety. Purchasers of such devices become general licensees and are subject to use conditions specified by the manufacturer.

NRC Broadscope Byproduct Materials License

Authority to possess and use a wide variety of byproduct radioactive materials which is issued by the NRC to organizations possessing a large and dynamic inventory of byproduct materials. (i.e. universities, certain R&D facilities, hospitals, etc.)

NRC Specific Byproduct Materials License

Authority to possess and use specifically-identified byproduct radioactive materials which is issued by the NRC to organizations possessing a relatively moderate and stable inventory of byproduct materials. Specific scope licenses offer less flexibility than broad scope licenses, but, have less stringent regulatory requirements to satisfy.

Occupational Radiation Workers

Individuals who are assigned to duties that expose them to radiation from licensed or unlicensed radioactive materials or sources

Radiation Area

An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in any one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radioactive Material (RAM)

Materials that exhibit the property of radioactivity.

Radioactive Materials Area

Any area where licensed radioactive materials are used or stored in amounts exceeding 10 times the quantity of such material specified in 10 CFR 20 Appendix C.

Radioactive Waste

Radioactive material that is no longer usable and is being packaged and processed for disposal.

Radioactivity

The process of undergoing spontaneous transformation of the nuclear, generally with the emission of alpha or beta particles, often accompanied by gamma rays.

Rem

The unit used for *dose equivalent*. The *dose equivalent* in *rem* is equal to the *absorbed dose* in *rad* multiplied by the quality factor. Also, 1 rem = 0.01 sievert.

Restricted Area

An area, access to which is limited for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Self-Luminous Light Sources

Gas, powder or paint containing a radioactive nuclide which is sealed and contained in a material that is strong enough to prevent leakage, during normal use and handling (exit signs, luminous switches, instrument dials).

Source Material

(1) Uranium or thorium or any combination of uranium or thorium in any physical or chemical form; or (2) Ores that contain, by weight, one-twentieth of 1 percent (0.05%), or more, of uranium, thorium, or any combination of uranium and thorium. Note: *source material* dose not included *special nuclear material*.

Special Nuclear Material (SNM)

(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Nuclear Regulatory Commission determines to be *special nuclear material*, but does not include *source material*; or (2) Any material artificially enriched by any of the foregoing but does not include *source material*.

Very High Radiation Area

An area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rad in any one hour at 1 meter from the radiation source or from any surface that the radiation penetrates.

BACKGROUND

Radioactive materials (RAM) and radiation-generating equipment are used safely throughout the industrial, medical and research communities. When not properly controlled, however, ionizing radiation can present a hazard to individual users and/or others in the immediate environment. Historical and scientific data tell us that very high doses of ionizing radiation received over a short period (“acute exposure”) and high exposures received over a long period (i.e., “chronic exposure”) present various health hazards to people. The Glenn Radiation Protection Programs establish the policies, procedures and responsibilities necessary for the safe operation and handling of radioactive materials and radiation-generating equipment.

POLICY

The Glenn Research Centers Radiation Protection Programs for Radioactive Materials and for Radiation-Generating Equipment are designed to maintain and preserve the health of our employees by eliminating unnecessary and accidental exposures and minimizing necessary exposures to ionizing radiation. Exposures to ionizing radiation are to be kept As Low As Reasonably Achievable (ALARA).

All uses of radioactive materials or radiation-generating equipment are approved by the Radiation Safety Officer (RSO) via either the materials application process or the safety permit process. Representatives of the Environmental Management Office periodically assess the ionizing radiation hazards of the activities. Also, the RSO is responsible for ensuring that an annual audit of the effectiveness of the Radiation Safety Program is conducted.

In addition to protecting our workers and the environment, the requirements and conditions of the Glenn Research Center’s Radiation Protection Program for Radioactive Materials demonstrates compliance with applicable regulations of the U.S. Nuclear Regulatory Commission (NRC) and the Occupational Safety and Health Administration (OSHA). Other regulations applicable to this program include those from the U.S. Environmental Protection Agency (EPA), the U.S. Department of Transportation (DOT), and the International Air Transport Association (IATA).

RESPONSIBILITIES

Occupational Radiation Worker – to satisfy training and other requirements of this chapter in addition to working in a safe manner in accordance with established procedures for their radioactive material.

Occupational Radiation Worker’s Supervisor – to ensure the user of radioactive material follows established procedures and meets requirements specified in this chapter and any applicable safety permits.

Radiation Safety Officer (RSO) – to ensure activities involving radioactive materials are conducted in accordance with applicable NRC, OSHA, DOT, IATA and NASA requirements. See [Appendix A](#) for detailed responsibilities.

Authorized User (AU) – to supervise the use of licensed radioactive material; to ensure that radioactive materials used in his or her particular lab or area are used safely and according to regulatory requirements; to ensure that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA.

Safety Committee Chairperson – to lead safety permit evaluations and provide guidance to the safety permit requester on how to satisfy permit conditions. In cases involving radioactive materials, the Safety Committee Chairperson will include the RSO as an ad-hoc member of their evaluation committee.

Shipper of Radioactive Materials – to ensure that shipments of RAM satisfy current DOT and IATA regulations pertaining to the shipment of hazardous materials; to satisfy DOT and IATA training requirements.

GRC Occupational Medicine Services – to provide medical surveillance and post-exposure evaluation, as well as follow-up actions, in accordance with NPR 1800.1. Records from such examinations/evaluations are to be retained for at least 30 years. Results of examinations are to be discussed with employees as needed.

Glenn Environmental Management Office (EMO) Chief – to provide support to the radiation safety officer in the performance of their duties.

Glenn Safety Office (GSO) Chief – to provide support to the safety committee chairpersons in the performance of their duties.

REQUIREMENTS

Training & Qualifications

User of RAM not covered by General License

NASA civil servants and SSC using radioactive sources/materials not included within a generally-licensed device, or a device specifically exempt from licensing, must receive radiation safety training prior to using the RAM and annually thereafter. Such individuals would be considered to be “occupational radiation workers.” This group would include individuals working with radioactive sources and the EMO staff supporting this use. This radiation safety training will be specified by the RSO.

Female radiation workers and their supervisors are also required to receive special instructions on the potential health risks of prenatal radiation exposure. The Radiation Safety Officer will provide this special instruction and document acknowledgement of such instruction.

User of RAM within a Generally-Licensed Device

Generally-licensed (GL) devices are designed to be inherently safe under reasonably expected use scenarios. The users must be trained to operate their specific equipment per any training and qualification criteria identified in the applicable BMS documents for said activity as well as the relevant safety permit. In addition, radiation safety training may be required by the RSO.

Industrial Radiographer using RAM

The Glenn Research Center does NOT possess an NRC license permitting its employees to use radioactive sources for conducting industrial radiography.

Construction contractors conducting radiography activities at temporary job sites (i.e., in the “field”) and their assistants must satisfy training and work experience requirements specified by the Ohio Department of Health in

Chapter 3701:1-66 of the Ohio Administrative Code. Records of such training and certification must be available to the Glenn Research Center's RSO upon request. If the radiographer is from another state and licensed by either that state or the NRC, similar training and work experience requirements would apply.

Shipper of Radioactive Materials

The employee designated as the shipper of radioactive materials must receive initial and periodic training in accordance with Subpart H of the DOT's 49 CFR 172 for hazardous materials. This training must be function-specific and relevant and must be repeated at least every three years. For shipments via air transport, the International Air Transportation Association (IATA) requires that such training be repeated at least every 2 years. The shipper of radioactive material must also be "certified" by their employer to be qualified to hold the position.

Medical Surveillance

Radiation medical examinations are conducted in accordance with the requirements set forth in NASA Procedural Requirements (NPR) 1800.1, NASA Occupational Health Program Procedures. Examination categories include pre-placement examinations, periodic re-examinations, situational examinations, and termination examinations. Inclusion in this program is required for employees receiving routine exposure to ionizing radiation in doses above 0.5 rem/year or 0.125 rem/quarter. Currently, no such exposures are anticipated for GRC personnel. Additionally, a situational examination may be appropriate for accidental exposures to potentially high doses of radiation or if a biological uptake (inhalation or ingestion) of a significant amount radioactive material is suspected.

Dosimetry & Dose Limits (see [Appendix B](#) for detailed guidelines)

The use of personal dosimetry to estimate external radiation exposure may be required for certain uses of RAM. The RSO will identify when and what type of dosimetry is required based upon the radioisotopes involved and how they are being used. At a minimum, the RSO should assign personal dosimetry to individuals working with RAM who are likely to receive an annual dose in excess of ten percent of their annual allowable limit. In practice, workers are typically assigned to use dosimetry at much lower exposure levels.

The following dose limits apply to individuals at the Glenn Research Center:

Occupational Annual Dose Limits

- WHOLE BODY: 15 Rem
- LENS OF EYE: 15 Rem
- EXTREMITIES, SPECIFIC ORGANS: 50 Rem

Gestation Period Dose Limit to Unborn Fetus of "Declared Pregnant" Radiation Worker

- WHOLE BODY: 0.5 Rem

Members of the Public Annual Dose Limit (due to occupational radiation sources)

- WHOLE BODY: 0.1 Rem

In practice, worker doses at the Glenn Research Center have historically been well below the stated limits. Should a worker's dose for a recording period appear unexpectedly high or, at a minimum, reach ten percent of the prorated allowable dose for that recording period, the RSO would initiate an investigation into the cause of the individuals dosimetry results.

Currently, all radiation dose-related activities at GRC involve working with radioactive materials or sources in such a manner as to only receive an "external" dose. Certain activities or working environments may also subject workers to "internal" sources of radiation dose. This internal component would also need to be taken into account when referencing the allowable limits stated above. Should the scope of activities at the Glenn Research Center expand to include tasks with internal radiation dose hazards, the RSO would need to revise the dosimetry program accordingly.

Employees who participate in the dosimetry program will receive an annual report summarizing their radiation exposure data per 10 CFR 19.13. Also, participants can, at any time, make such a request. For workers engaged in licensed activities, this report must contain the following statement (or similar): "This report is furnished to under the provisions of the Nuclear Regulatory Commission regulation 10 CFR 19. You should preserve this report for further reference." In addition, former employees engaged in licensed activities can request a dose history for their time at GRC, which must be satisfied within a specified time frame.

Contamination Control

Improper handling of non-sealed radioactive sources or the loss of integrity of a “sealed source” could result in the spread of radioactive materials to nearby personnel, equipment, and environment. For most radioisotopes, a relatively small amount of radioactive material is readily detectable on one’s skin or clothes, or on working or equipment surfaces, and is, typically, unacceptable. Decontamination of individuals, areas or equipment may be the proper course of action. Building materials or other items not readily decontaminated may need to be disposed of as radioactive waste. More specific guidelines are provided in [Appendix C](#).

Radiological Surveys of Sources, Equipment, and Facilities

Various radiological surveys need to be conducted periodically to verify the radioactive materials and their emitted radiation are under control. The frequency of performing such surveys may be prescribed by DOT or NRC regulations, our NRC license requirements, or conditions specified for a generally-licensed device containing a nuclear source. The radiation safety officer is also responsible for establishing periodicities for radiological surveys of facilities where radioactive materials are utilized, handled or stored. Surveys are to be documented using a GRC “Radiological Survey Form.”

Surveys conducted in support of source receipt or shipment are specified in Appendices E and G, respectively. Other survey requirements are summarized in [Appendix D](#).

Material Receipt and Accountability

PRIOR to purchasing OR receiving any radioactive materials or devices containing such materials, individuals must contact the Radiation Safety Officer to discuss relevant requirements associated with using the RAM or device.

- The RSO will determine if there are licensing issues associated with the new source. For example, does GRC’s current material license allow for possession of the source or would the license need to be first amended? If the RAM is contained within a “generally-licensed” or “license-exempt” device, what are the restrictions or conditions of use associated with the general license or license exemption?

Note: Amendments to our NRC materials license can take up to 2 weeks to prepare and submit, assuming all necessary information is available. The NRC could take up to 90 days to approve the proposed amendment. Receipt of the radioactive material would not be legally authorized until the RSO has received notice from the NRC.

- The RSO will determine if use and storage locations of the device afford adequate safety and security. Facilities must have adequate shielding characteristics for the radioactive source and must enable employees to work with the source safely. The proposed facility must also allow for adequate control of the RAM.
- The RSO will assess post-use storage and disposal issues associated with the RAM or device.
- The RSO will establish needs for worker training, engineering or administrative controls, radiation dosimetry, etc.

Labeled radioactive materials packages shipped to the Glenn Research Center will be processed by the receiving office in accordance with [Appendix E](#). Since receipt of such packages is typically coordinated by the radiation safety officer, the RSO will, when feasible, notify shipping and receiving personnel of the estimated arrival date of the expected package.

The RSO or other EMO “health physics” representative will open the package in accordance with [Appendix E](#) and good RAM-handling practices. A form C-811 “Radioactive Material Receipt and Inventory Record” will be completed and placed in the appropriate RAM file folder along with any shipping or manufacturer’s information for the item. In addition, the radioactive source inventory will be updated with as much information as possible documented. When receiving activated materials or components that contain multiple isotopes, inventory entry should identify the item and list the necessary information for each isotope.

Inventories of licensed, generally-licensed and unlicensed radioactive material will be conducted every six months. The RSO, other EMO “health physics” staff, and Plum Brook EHS staff may be involved in the inventory process. Upon completion of the inventory, the RSO will print off the current inventory and place the list in the appropriate file.

Internal transfers of radioactive sources and equipment must be coordinated with the EMO “health physics” function and approved by the RSO. This notification is necessary to ensure RAM is appropriately tracked and that any safety and security issues associated with the new location are assessed.

Authorization of RAM Users

Employees must satisfy whatever license or safety permit conditions exist for using a particular radioactive source or device containing RAM. Most operations involving the use of RAM should be covered under the Glenn Safety Office's safety permit system, which provides a convenient mechanism (qualified operator's list, C-580 and the safety permit, C-919) for calling out conditions and qualifications pertaining to use. Since the RSO should be a member of the evaluation committee, which established the safety permit conditions, such requirements and qualifications related to radiation protection issues would be considered to be approved by the RSO.

Safe Use of Radionuclides and Emergency Procedures

An operating procedure, which describes how and where the radiation source will be used, must be submitted to the RSO. The level of detail of these procedures will vary depending upon the complexity of the activity. Procedures for the use of generally-licensed devices containing RAM might only include the manufacturer's instruction manual. For experiments involving radioactive sources, procedures must be developed which address, in detail, what safety precautions are being taken and how the work will be done safely. These procedures will be reviewed and approved by the Radiation Safety Officer.

Depending upon the type, form, and activity of the source, emergency procedures might also need to be developed. Elements of emergency procedures involving spills or releases of radioactive material are summarized in [Appendix F](#).

Safety Permits

GSO's safety permit process is used as a vehicle for assessing and addressing potential health and safety hazards associating with activities at the Glenn Research Center. The radiation safety officer will assist area safety committees in determining requirements, controls, and conditions for a safety permit involving the use of radioactive materials. Typical permit conditions would include training, posting/labeling, the use of radiation dosimetry, periodic radiation surveys, and written procedures. There are certain items containing radioactive materials the could be considered inherently safe, such as certain generally-licensed or license-exempt devices; such items might require less-stringent use conditions. The RSO would be responsible for making such a determination and would advise the safety committee chair whether or not safety permit conditions were needed to address the use of the RAM-containing device or item.

Postings, Notifications, Reports

The following documents are required to be posted in areas where licensed radioactive materials are used or stored:

- NRC Form 3 "Notice to Workers"
- 10 CFR Parts 19, 20, 21, Section 206 Energy Authorization Act, procedures adopted pursuant to Part 21, and license documents (in lieu of posting these documents a notice can be posted which identifies where said documents can be examined).

The RSO must submit reports to the NRC in accordance with 10 CFR 20.22xx for

- Theft or loss of material
- Notification of incidents such as high exposures or releases of material
- Reports of exposures, radiation levels, and concentrations of RAM exceeding limits
- Reports of planned special exposures.

Specific time and reporting method requirements are identified in the regulations.

Requirements for notifications and reports related to dosimetry issues are summarized in the "dosimetry and dose limits" section.

Area Postings/Controls and Container Labels

Restricted, radioactive material, radiation, high radiation, very high radiation, and contamination areas shall be marked clearly with signs as designated by the RSO. The signage should also indicate any special requirements pertaining to the particular area. Standard signs prescribed by NRC and OSHA regulations are available from the RSO.

The RSO shall assure that routine surveys of restricted areas, including radiation and contamination surveys, are conducted at prescribed frequencies.

Smoking, eating, and drinking are prohibited in restricted areas.

Containers of licensed materials shall bear a durable, clearly visible label bearing the radiation symbol and an appropriate warning statement. The label should also include sufficient information regarding the contents so that individuals handling or using the containers, or working in the vicinity of the containers can take appropriate action to avoid or minimize exposure. (10 CFR 20.1904) Exemptions to labeling requirements are identified in 10 CFR 20.1905.

Radioactive Waste Management

Radioactive wastes generated on sight must be appropriately stored prior to disposal; shielding, posting/labeling, and security must be considered. The RSO will approve of all radioactive waste control procedures and corresponding facilities. Radioactive waste guidelines are provided in [Appendix I](#). Disposal of radioactive materials (liquids, solids or gas) must be coordinated with the EMO “health physics” function and approved by the RSO. The RSO will work with the waste management group and the radioactive materials shipper to ensure license conditions and regulations (NRC, DOT, EPA) are satisfied.

Transportation of Radioactive Materials and Wastes

All shipments of radioactive materials and radioactive wastes will be coordinated by the radiation safety officer. Packages for shipment must satisfy D.O.T. criteria for the type of shipment planned and a copy of the shipping container’s certification should remain with the source transfer documentation in the RSO files. Classifications of shipments include those identified as limited quantities/excepted articles, Low Specific Activity (LSA) objects, Surface Contaminated Objects (SCO), Type A quantities, Type B quantities, and Highway Route Controlled Quantities (HRCQ). Packaging of certain materials, such as a Type B source, requires that the packager have a quality assurance program established for that specific activity. GRC does not have such a QA program, so any shipments of such materials would have to be packaged by a representative of an appropriately qualified contractor.

Prior to shipment, the RSO must receive a copy of the prospective recipient’s materials licensee to ensure that they are, in fact, authorize to receive the radioactive material. This license and any supporting documentation must specify that the actual physical location receiving the RAM is authorized to possess the item(s). A copy of this record should also be maintained in the source transfer documentation of the RSO files.

The RSO will also work with the shipping office to discuss shipping options and other issues associated with upcoming shipments. The RSO or other EMO “health physics” representative will prepare a C-359 “Radioactive Shipment Certification Record” in addition to a C-727 “Shipping Request Document” and provide them to the radioactive materials shipper. This individual will prepare the paperwork required for type of shipment identified.

The Department of Transportation (DOT) serves as the regulatory authority for most shipments of radioactive material. Applicable requirements can be found in parts 171-178 of their shipment hazardous materials regulations, Subpart C of the Code of Federal Regulations Title 49. For instances where the DOT regulations might not apply to a licensed RAM shipment, the requirements of the NRC’s 10 CFR 71 would need to be satisfied. For air shipments of radioactive materials, requirements specified by the International Air Transport Association’s (IATA) “*Dangerous Goods Regulations, Section 10 – Radioactive Material*” would also need to be satisfied.

More specific guidance on shipping requirements can be found in the NRC, DOT and IATA regulations cited in the previous paragraph. Applicable guidance for the most common RAM shipments from GRC is included in [Appendix G](#).

Construction Contractor Use of Radioactive Sources

Contactors periodically use devices containing RAM to perform certain tasks. One such device would be the camera used when performing industrial radiography imaging of welds in piping systems, tanks or other critical mechanical systems. This process relies on the energetic photons (i.e. gamma-rays) from a radioactive source to “x-ray” the zone of interest. Iridium-192 and cobalt-60 are the two most common nuclear sources used by today’s radiographers. Individuals performing source radiography must have a radiography license issued by the NRC or, in the case of an agreement state, the appropriate state agency. There are strict training and performance criteria and control requirements that must be satisfied to obtain such a license.

Construction engineering companies may also use portable density gauges, containing radiation sources, usually Cesium-137, Americium-241 or possibly Radium-226. These gauges are used to measure the density and composition of surfaces. The latter two radioisotopes may be combined with beryllium metal, resulting in a neutron-emitting source that could be used for measuring moisture density in a material such as soil. Gauge users would be required to have a

radioactive materials license issued by the NRC or comparable state agency. Again, there are license conditions that must be satisfied to use the gauges; although, these requirements are not as rigorous as those associated with the radiography process. The construction contractor is responsible for the safe use and safety storage of the density gauge. When not in use, the device should be secured in an area away from operating heavy equipment to minimize the chance of a construction vehicle accidentally crushing or damaging the shielding of a carelessly unattended gauge resulting in the source becoming exposed or dislodge.

Approval for performing the above-mentioned activities or other contractor task involving radioactive material is be obtained via the Glenn Safety Office's "Health And Safety Plan" (HASP) process. The RSO will review and approve aspects of the contractor's HASP related to using RAM. More specific guidance on these construction activities and RSO approval is provided in [Appendix H](#)

Self-Luminous Exit Signs

Self-luminous exit signs found throughout the center utilize radioactive tritium gas and a phosphorous material to product light. These signs are possessed under a general license (10 CFR 31.5) and are maintained, controlled, and disposed of by the support service contractor (SSC) responsible for such facility attributes. License conditions for such signs include keeping labeling in tact, not abandoning the sign, proper disposal, and certain reporting requirements. Damaged, lost or stolen signs should be reported to the RSO. The RSO will work with the SSC to make required reports to the NRC per guidance in NUREG-1556, Vol. 16, Appendix L.

RECORDS (maintained by RSO or HP)

- Annual Occupational Radiation Worker Training
- Contamination and Radiation Surveys
- Sealed Source Leak Tests
- Instrument Calibrations
- Generally-Licensed Source Inventory
- Licensed Source Inventory
- Radiation Dosimetry Reports
- Radioactive Material Receipts
- Radioactive Waste Disposals
- U. S. Nuclear Regulatory License #34-00507-16
- Unusual Incident Reports
- Users Radiological Training & Experience Files
- Written Examinations

References

- U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Regulations, Chapter 1
- ANSI/HPS N43.4-2000 – Classification of Radioactive Self-Luminous Light Sources
- U.S. Occupational Safety and Health Administration – 29 CFR 1910.1096 – Ionizing Radiation
- NASA Procedural Requirement, NPR 1800.1 NASA Occupational Health Program Procedures
- U.S. Department of Transportation, Title 49, Code of Federal Regulations, Subchapter C – Hazardous Materials Regulations, Parts 171-178
- International Air Transport Association (IATA), *Dangerous Goods Regulations*, Section 10 – Radioactive Material.
- U.S. Nuclear Regulatory Commission, NUREG-1556, Vol. 7, Consolidated Guidance About Materials Licenses – Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope.
- U.S. Nuclear Regulatory Commission, NUREG-1556, Vol. 16, Consolidated Guidance About Materials Licenses – Program-Specific Guidance About Licenses Authorizing Distribution to General Licenses.

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Last Revised: July 2004

EPM Chapter 28, Radiation Protection for Radioactive Materials
Appendix A
Radiation Safety Officer Responsibilities

The RSO is appointed by the Director to implement the radiation protection programs at the Glenn Research Center (GRC). The RSO's responsibilities include the following:

1. Administer and coordinate the radiation protection programs for all activities involving radioactive materials and ionizing radiation-generating equipment and to ensure that the programs conform with Nuclear Regulatory Commission (NRC) and Occupational Safety and Health Administration (OSHA) regulations as well as NASA policy.
2. Serve as the RSO for all NRC licenses issued to the GRC and determine compliance with license conditions.
3. Provide health physics services and consultation to personnel at GRC. Such services shall include the following:
 - a. Provide, distribute, and maintain personnel radiation monitoring equipment (i.e. dosimetry); assess exposures recorded by such personal monitoring equipment; maintain exposure records.
 - b. Coordinate the radioactive waste disposal program; provide, collect, store, and dispose of waste containers; monitor effluent; maintain filter systems; maintain waste disposal records.
 - c. Supervise the performance of sealed source leak test; maintain inventories.
4. Control all licensed radionuclides at GRC as follows:
 - a. Review and approve all requests for procurement of radioactive material.
 - b. Assure that sources are properly represented on the center materials license.
 - c. Maintain an inventory of radioactive materials at GRC; conduct physical inventories at least semi-annually to comply with license requirements.
 - d. Upon notification of receipt of radioactive material shipment, coordinate package survey(s) and open package in approved area; maintain material receipt records.
 - e. Authorize all transfers of radioactive materials between center locations
 - f. Approve containers and locations for storage of all radioactive materials.
 - g. Package or inspect packaging for all off-site transfers of radioactive material; survey packages; assure compliance with NRC and DOT regulations; maintain shipment records.
5. Conduct or coordinate training programs in radiation safety.
6. Maintain all records related to the radiation protection programs.
7. Terminate any activity involving radioactive material or ionizing radiation that is found to be a threat to health or property.

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Appendix B

Guidelines for Personal Dosimetry

Obtaining Dosimetry

Individuals needing radiation dosimetry are to contact the RSO. After satisfying training requirements and providing needed personal information, the individual will be issued their dosimetry and instructed on its use. New occupational workers are also required to provide the RSO with a record of occupational dose from previous employment. Information such as a new worker's accumulated dose for the current calendar year and any past "special exposures" will allow the RSO to appropriately manage their dose received in their inception year and over their career at the Glenn Research Center

Temporary Need for Dosimetry

Temporary monitoring devices can be issued to transient personnel who may be assigned short-term work in a radiation area. The RSO will evaluate the radiation area and assign monitoring devices as appropriate.

Specification of Dosimetry Type

The need for and type of radiation dosimetry assigned is based upon the characteristics of the ionizing radiation and the type of activity involved. Dosimeters are used to estimate an individual's radiation dose caused by external sources of radiation.

Use of Dosimetry

Whole Body

"Whole body" dosimeters are used to estimate the radiation dose delivered to the head, trunk and thigh area of a worker. This region of the body includes the major organs and blood forming areas that would be more susceptible to chronic radiation exposure effects. The "whole body" badge is to be worn in its holder on the front of an individual's body in between their head and waist.

Self Reading

Self reading dosimeters (SRD) are used to provide a "real time" estimate of an individual's dose to x-rays or gamma rays. SRD's are typically worn in addition to an individual's "whole body badge" when that individual could be involved in an activity involving higher dose rates. The self reading dosimeter is to be worn similarly to the "whole body" badge. SRD's are to be checked by the user periodically during the exposure event to keep tabs on a worker's accumulated exposure. The dose estimated from an SRD is used for guiding actions during an exposure scenario. The SRD dose does not become the individual's official dose of record.

Ring and Extremity Badges

Ring or wrist badges may be specified for activities where a worker's hands come in closer contact to the field of ionizing radiation than their body. Ring badges have higher detection thresholds than whole body badges, and, along those lines, exposure limits for extremities are an order of magnitude greater than whole body limits.

Notify the RSO Immediately

There are certain situations where dosimetry wearers would need to notify the RSO immediately. Users would need to provide a written account detailing the event...who else was involved, when did it occur, what were the radiation characteristics, how long, etc. Situations would include, but are not limited to:

Lost Dosimetry – if you are unable to find your badge following its use for exposure monitoring.

Damaged Dosimetry – if your badge's physical integrity was compromised

Irradiated While Not In Use – if your badge was dropped in an area that subsequently received a high radiation dose

Forgot to Wear a Badge – if you proceeded in performing dosimetry-required activities without being monitored.

Involved in a Potential High Exposure – if you suspect you might have received an acute high dose.

In all but the last of these scenarios, the user would be assisting the RSO in finding a way to estimate the individual's true dose for the exposure scenario. Notification in a potential high dose incident is needed to manage the affected individuals' dose(s).

Additional Guidelines for Dosimetry Users

- Wear your dosimeter as specified for the work being performed
- Know where your dosimeter (s) is at all times
- Use only the dosimeter assigned to you
- Use your assigned dosimeter only at GRC's Lewis Field or Plum Brook Station, and only in the areas for which it was assigned
- Never intentionally irradiate your dosimeter to check the accuracy of the radiation safety process
- If you have a medical procedure requiring the use of a radioactive tracer, contact the RSO and do not wear your dosimeter until the tracer has dissipated
- Consult with the RSO regarding any concerns or questions on the use of dosimetry or the dosimetry program
- Dosimetry reports are on file with the RSO. Program participants receive an annual record of their dose and are advised to keep such records for their personal use.

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Appendix C
Contamination Control Guidelines

Personnel Contamination and Personal Protective Equipment (PPE)

1. Individuals shall wear impermeable gloves (i.e., latex, nitrile, etc.) while working with radioactive materials. Gloves are to be removed when work is completed. Gloves that are suspected of being contaminated should be isolated and the RSO contacted.
2. All persons working with radioactive materials where personal contamination is possible, shall wash their hands thoroughly before leaving the work area. If directed by the RSO, monitoring equipment will be utilized to verify removal of contamination.
3. The user shall immediately contact the RSO or their designee if personnel contamination is suspected.
4. Open wound must be dressed and covered by impermeable PPE when working with radioactive materials of any form.

Personnel Decontamination

In general, any contamination of body surfaces should be addressed by prescribed decontamination methods. Such activities should be performed by or under the supervision of the RSO or an EMO “health physics” representative. Decontaminating agents and methods may become increasingly abrasive depending on the type and level of contamination present.

Here are some initial precautions that can be taken until a radiation safety specialist arrives at the location:

1. Take steps to prevent the spread of contamination, such as isolating the area and if liquids are involved, place absorbent material over any spills
2. Determine the areas of contamination on the individual with the use of monitoring equipment or survey instruments, if available.
3. Decontamination of wounds should be done under the supervision of a physician
4. The adhesive backing of duct tape (or similar) can be used as a preliminary method to remove contamination from skin or clothing.
5. Skin areas that are contaminated should be lathered for **3 minutes and repeated 3-4 times**
6. After the decontamination process has been completed, the individual should take a thorough shower, giving special attention to the hair, hands and fingernails

Area Contamination

1. Removable contamination would not be tolerated on exposed surfaces, such as bench tops and floors and should be removed as soon as possible (or isolated). Small amounts of fixed contamination may be unavoidable at time, but, the degree of such contamination shall be kept as low as possible.
2. The RSO shall assure the surveys of contamination levels are scheduled and that these levels do not exceed the limits established in this program.
3. Any operations involving gaseous, finely divided, or particulate radioactive material shall be carried out in an appropriately designed laboratory hood, glove box, or similar equipment approved by the RSO.
4. The user shall immediately contact the RSO or their designee whenever contamination is suspected.

Contamination Limits

Unrestricted Use

Contamination found in unrestricted areas should be immediately decontaminated to background levels, if possible. When such levels are not feasible, the contamination levels observed should at least be less than the limits specified in the table below. This table conservatively summarizes applicable guidance from NUREG-1556, Vol. 7 and Regulatory Guide 1.86. Note that the isotopic variation in allowable contamination levels identified within these two references is not reflected within the table; rather, a more conservative limit is identified to simplify the survey process. If required, a more sophisticated contamination assessment could be conducted under the direction of the RSO.

Maximum Permissible Contamination Levels for Unrestricted Use

Surface	Fixed		Removable	
	Alpha (dpm/100cm ²)	Beta-Gamma (dpm/100cm ²)	Alpha (dpm/100cm ²)	Beta-Gamma (dpm/100cm ²)
Equipment, Articles, Tools, etc.	100 average 300 maximum	1,000 average 3,000 maximum	20	200
Building Surfaces – Bench Tops, Floors, etc.	500	5000	50	500

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Appendix D
Summary of Radiological Survey Requirements

Source Leakage Tests

Sealed sources shall be leak tested in accordance with NRC license conditions or applicable Sealed Source Device Registry criteria. Generally-licensed devices shall be leak tested in accordance with the manufacturer's stated wipe test criterion. The method for monitoring any removable activity shall be capable for detecting the type of emission(s) expected from the subject radioisotope and shall have a detection limit of at least 5 nanocuries. The RSO will establish the required periodicity for conducting such tests and specify the monitoring method to be used.

Area Radiation Surveys

Radiation surveys shall be conducted in areas where radioactive materials are present and should be repeated whenever the source term in the area changes significantly. These surveys are conducted to verify the adequacy of shielding and other established engineering controls.

Area Contamination Surveys

Periodic contamination surveys are to be conducted in areas identified by the RSO to ensure that radioactivity is being adequately controlled. The method and frequency of survey will depend on the form of the RAM and the activities taking place.

Radiography Radiation Surveys

Contractor radiographers must perform monitoring during radiography activities to comply with their license and other regulatory requirements. At times, the RSO or EMO "health physics" representative may observe such activities and, in doing so, verify the proper establishment of the 2 mR/hour boundary.

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Appendix E

Material Receipt and Accountability

Receiving Radioactive Materials Packages

The following procedures are guidelines for the NASA Glenn staff who will be processing the receipt of labeled packages containing radioactive material. “Labeled” refers to the DOT shipping labels for radioactive materials (i.e. “White I,” “Yellow II,” or “Yellow III”). Receipt of radioactive materials received under “excepted” classifications, are subject to more relaxed receipt procedures.

Note: DO NOT send the package to Building 212 as hazardous material)

Note: A sign is posted in the Receiving area with examples of radioactive labels to look for on the packages and an explanation of what the labels mean.

Note: The Glenn Research Center does not have an after-hours shipping and receiving process.

During normal working hours, immediately upon receipt of any labeled package of radioactive material, Receiving Office personnel must visually inspect each package for any signs of shipping damage such as crushed or punctured containers or signs of dampness. Any obvious damage must be reported to the RSO or other designated EMO employee immediately (see below). Workers should be kept away from the location of the damaged package and the parcel should not be moved or touched. In addition, the person delivering the damaged package should be asked to remain at the dock area until that individual and their vehicle can be appropriately monitored. Efforts should be made to limit the potential spread of contamination from the suspected leaking package.

The Receiving Office must notify the RSO or other designated EMO employee upon the receipt of a package containing radioactive material or sources. EMO “health physics” staff are required to monitor the package within 3 hours of receipt. For deliveries that occur after “core working” hours, the notification can be made at the start of the next work day. The Receiving Office must notify an EMO “health physics” contact **FIRST** regardless of to whom the package is addressed. The EMO “health physics” representative will pick-up the package and notify the addressee after all license and regulatory requirements have been met

EMO Contacts are (in order of notification priority):

Chris Blasio, Radiation Safety Officer	433-6520, pager 549-1215
Richard Miller, Environmental Protection Specialist	433-3780, pager 549-2330, cell 403-8170
Jeffrey Wagner, Environmental Protection Specialist	433-3770, pager 549-xxxx, cell 701-0447
Gayle Reid, Occupational Health Lead	433-3173, pager 549-2087

Opening Radioactive Materials Packages

EMO “health physics” personnel are responsible for opening radioactive materials packages. Unless otherwise directed by the RSO, such packages will be opened in room 3 or 4 of building 49 or in source storage area of building 140. Procedures for opening radioactive materials packages are as follows:

Note: Record all survey measurements and information using the GRC “Radiological Survey Form.”

- Wear gloves when handling packages to prevent potential hand contamination
- Visually inspect the package for any sign of damage (e.g., crushed, punctured, dampness). If damage is noted, stop and notify the RSO.
- Measure the dose rate from the package at 1 meter and at the package surface. If it is higher than expected, stop and notify the RSO. The expected dose rate in mrem/hr at 1 meter should be close to the “transportation index” value noted on the package label. The expected maximum dose rates (mrem/hr) at the surface of the package are as follows: 0.5 for White I, 0.5 to 50 for Yellow II, and 50 to 200 for Yellow III.

STOP POINTS: > 10 mrem/hr at 1 meter, or > 200 mrem/hr on contact – Call RSO Immediately & Do Not Open Package

Note: The final delivery carrier and NRC Operations Center (301-816-5100) must be immediately notified by telephone if the radiation survey results for the package exceed the levels identified in 10 CFR 71.14.

- Wipe at least 300 cm² of the exterior surface of the package and analyze the wipe.

Note: The final delivery carrier and NRC Operations Center (301-816-5100) must be immediately notified by telephone if the contamination survey results for the package exceed the levels identified in 10 CFR 71.87(I).

- Remove the packing slip
- Open the outer package following the supplier's instructions, if provided.
- Open inner package and verify contents with packing slip and label on container
- If the contents, packing slip and label do not match or exceed possession limits, contact the RSO immediately
- Inspect the source container for damage, loss of liquid or discoloration of packing material
- Survey packing material and package before disposal. If contaminated, dispose of as radioactive waste. If not contaminated, remove or obliterate radiation labels and dispose of in the regular trash

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Appendix F
Emergency Procedures

INCIDENT INVOLVING RADIOACTIVE RELEASES OR SPILLS

All emergencies in areas where radioactive materials are being used shall be reported by dialing **911 to contact Glenn Dispatch**. The dispatcher will send the First Responders to the scene and immediately initiate contact with the RSO or other EMO personnel identified in Appendix L of the center's Emergency Preparedness Plan (EPP).

Procedures for the Radiation Worker or the First Responders:

- Notify all personnel in the area that a spill has occurred
- Confine all movement that may spread contamination
- Seal off all ventilation to minimize the potential release of airborne particulates
- Lock the room or barricade the area
- Notify the Health Physics Team

Procedures for the EMO "health physics" personnel:

- Stop the release of radioactive material from the source, and shield as appropriate
- Shield the source if this can be done without significant increase in direct radiation exposure, or cover the area with absorbent material (**Appropriate shielding will be determined by the Health Physics Team**)
- Contaminated clothing should be removed as soon as possible and placed in a plastic bag
- Skin should be flushed with water, and then washed with soap and water

INCIDENT INVOLVING A STUCK RADIOGRAPHY SOURCE

The Construction Contractor Radiographer should initiate their written emergency procedures and any other actions identified in their Health and Safety Plan. This should involve contacting the Glenn Dispatcher, who, in turn will dispatch the First Responders and contact the RSO or other EMO personnel identified in Appendix L of the center's Emergency Preparedness Plan (EPP). Since two licensed personnel are required when performing radiography, at least one should be available to initiate this sequence of events, even if their partner is incapacitated.

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Appendix G
Transportation of Radioactive Material

As discussed in the chapter, the Department of Transportation (DOT) and the International Air Transport Association (IATA) are regulatory authorities for most RAM shipments likely to be made by the Glenn Research Center. The Nuclear Regulatory Commission's (NRC) 10 CFR 71.5 (b) states that if DOT regulations are not applicable to a shipment of licensed radioactive material, the licensee is required to comply with the NRC regulations, in 10 CFR 71.5 (a), which state that licensees who transport licensed material to a location outside of the site where it is being used, shall conform to the standards and requirements in 49 CFR Parts 170-189 to the same extent as if the rules were applicable.

Guidance summarizing the DOT requirements is as follows:

Licensee Documentation Requirements

Described in text of main chapter

Shipping Container Certification Document Requirements

Described in text of main chapter

Classification

There are different levels of DOT requirements regarding shipment classification. These include:

- Exemptions – if quantity or form is not considered a hazardous material, the shipment is exempt from DOT rules.
- Excepted Packages – if the quantity or material or its housing within a instrument/article satisfy requirements stated within 49 CFR 173.421-426, then that shipment is thought to pose minimal hazard and may be shipped using relaxed DOT rules therein identified. Another category of excepted packages are shipments of empty packages used to ship radioactive sources. (173.428)
- “Special Form” or “Normal Form” (173.403 and 173.469) – determination of source “form” is needed appropriately classify a sealed source. The “special form” designation indicates that the source encapsulation is strong or robust enough to satisfy a series of physical tests. Such classification is indicated by a certification for the source which is typically issued by either the DOT or NRC. Copies of this certification should be submitted with the shipping paperwork and maintained in the RSO's files for transferred sources.
- Type A Quantity – The A₁ and A₂ quantities found within 173.435 indicated the maximum quantities that can be shipped in a “Type A” package for special form and normal form sources, respectively.
- Type B Quantity – Quantity of radioactive material that exceeds the A₁ and A₂ quantities found within 173.435 for special form and normal form sources, respectively.
- Highway Route Controlled Quantity – Quantity of radioactive material that exceeds 3000 times the A₁ and A₂ quantities found within 173.435 for special form and normal form sources, respectively.
- Low Specific Activity (LSA) and Surface Contaminated Objects (SCO) – Specials categories of shipments that allow for relaxation of DOT rules based upon the reduced hazard associated with shipment.

The RSO will determine the appropriate item classification.

Radiological Surveys and Radiation Limits

Generally radiation dose rates at package surfaces and at 1 meter from the package surface are limited to 200 mrem/hr and 10 millirem/hour, respectively. If these levels are exceeded that package must be shipped “Exclusive Use” and may not be transported by aircraft. “Exclusive Use” shipments are subject radiation limits specified in 49 CFR 173.441(b).

The radiation level measured at 1 meter from the package surface is used to determine the “Transportation Index,” or “TI,” of the package. Simply put, the TI is the maximum dose rate in millirem per hour (rounded to the nearest tenth) measured at 1 meter from the package surface. If the dose rate is less than 0.05 mrem/hr, the TI is defined to be 0.

Levels of non-fixed (removable) surface contamination on the package must be kept as low as reasonably achievable (ALARA) and are not permitted to exceed the limits identified in 49 CFR 173.443. The contamination wipe surveys

are to be taken over an area of at least 300 square centimeters. The allowable limits are 22 dpm/cm² for beta and gamma emitters (and low toxicity alpha emitters), and 2.2 dpm/cm² for all other alpha emitting radionuclides.

Packaging

Packaging requirements are specified based upon the classification of the source as well as its physical form (i.e. solid, liquid, gas), and even the mode of transportation. General package design requirements are specified in DOT 49 CFR 173.410 and include considerations for handling, lifting, securing for shipment, ability to decontaminate, water shedding, durability against forces experienced during shipping, chemical compatibility with contents, and pressure and temperature extremes for air transportation. Additional design and testing requirements apply to packages identified as “Type A” (173.412 and 415) or “Type B” packages (173.413 and 416).

Marking

Type A: Packages are to be marked with the proper shipping name and identification number. Example, “Radioactive material, special form, n.o.s., 7, UN2974.” Be sure to consult with the current DOT (49 CFR 172.3xx – Subpart D) or IATA shipping names, as appropriate, since these categories are revised periodically. The RAM shipper is responsible for identifying the correct shipping name. Other requirements include “Type A” marking, and a “RQ” marking if a “reportable quantity” of a radioisotope is being shipped. Air shipment packages are also required to be marked with the name of the packaging manufacturer. Finally, Type A shipments need to be marked with the name and address of the consignee or consignor (both for air shipments.)

Labeling

Package labeling provides information about the sources within the package, their corresponding activities, and the radiation levels measured at one meter from the package. Isotopes can be identified as Cesium-137 or Cs-137. Activities must be provided in S.I. units (i.e. Becquerels), although shippers commonly include the activities in Curies within parentheses. For multiple sources shipped within the same container, the label must include the identification of the isotopes that comprise 95% of the total activity. For air shipments, the label should also break down the activity contact by isotope. The radiation level required on the label is also known as the “transportation index,” or “TI.”

There are three primary labels used on radioactive materials and their selection is based upon the package surface radiation levels and the TI. The shipper must affix two White I, Yellow II, or Yellow III labels on opposite sides of the container (not the bottom) near the marked proper shipping name.

Label Type	Surface Radiation Level (mrem/hr)	TI
White I	Up to 0.5	N/A
Yellow II	>0.5 to 50	>0 to 1.0
Yellow III	>50 to 200	>1 to 10
Yellow III – Exclusive Use	>200 to 1000	>10

Other labeling requirements or considerations include:

- “Cargo Aircraft Only” label for packages authorized for cargo aircraft transport
- Subsidiary Hazard labels for other hazards associated with the package
- Unlawful to transport a package bearing a label unless the package contains the hazardous material and the label represents the hazard presented by the material present.

Shipping Papers

The following information must be included within the shipping paperwork for a Type A shipment:

- Proper shipping name, hazard class, UN number
- Name of each radionuclide as listed in 49 CFR 173.435. (172.203(d)(1) and (2))
- Description of the physical and chemical form of the RAM (172.203(d)(3))
- For air transport, the statement “All packed in one type A container” should follow the entries
- If applicable, “RQ” (Reportable Quantity) must appear before or after the basic source description (172.203(c)(2))
- Activity in SI units (i.e. Becquerels) (172.203(d)(4))
- Category of the label applied to the shipment (172.203(d)(5))

- Transportation Index (172.203(d)(6))
- For air transport, the dimensions of the package
- For air transport, “Cargo Aircraft Only” statement on shipping paper if found on package. (172.203(f))
- Shipper’s certification statement and signature. (172.204(a) and (d))
- Statement “Exclusive use Shipment” if applicable

Emergency Response Information (49 CFR 172.6xx, Subpart G)

Emergency response information for RAM being shipped is required to be maintained by the carriers transporting the hazardous material along with the facility operators who receive, store or handle the hazardous material during the transportation process. The information must be immediately available to vehicle operators, pilots, etc. or facility personnel, and is required to be on-hand as long as the radioactive material is in transit. The information is provided to mitigate an incident involving RAM and must include: (1) a description and technical name of the material, (2) immediate hazards to health, (3) risks of fire or explosion, (4) immediate precautions to be taken during accident, (5) immediate methods for handling fires, (6) initial methods for handling spills, and (7) preliminary first air measures.

The party offering the material for shipment must also provide a 24-hour emergency response telephone number for use in the event of an emergency involving the hazardous material. This number must be monitored as long as the RAM is in transit and must contact the caller with a person who has specific knowledge of the radioactive material in shipment, or with access to someone with specific knowledge.

The information must be printed legibly in English and be available for use away from the RAM package. The information could be presented on (1) a shipping document, (2) on another document providing the required information (e.g. “material safety data sheet” or similar), or (3) in an emergency response guidebook document that is referenced in the shipping paperwork.

Placarding (49 CFR 172.5xx, Subpart F)

Vehicle placards are required to be utilized on the following shipments of radioactive materials:

- Yellow III shipments
- Yellow III Exclusive Use Shipments
- LSA, SCO Exclusive Use Shipments
- Highway Route Controlled Quantity Shipments (black-bordered placard)

Placards are required to be placed on the front, back and two sides of the vehicle.

Special Classifications

Certain radioactive material or items containing RAM can be grouped into “Excepted (Limited) Quantity” categories. (49 CFR 173.421 – 126) These classifications permit the package to be excepted from specification packaging, marking, labeling, shipping paper and certification requirements as long as the item is not considered hazardous waste. Note, that excepted does not mean exempted. These categories include the following: Limited quantity radioactive sources, radioactive instruments and articles, and articles containing natural uranium or thorium. A related category of excepted packages are shipments of empty radioactive materials packaging (173.428). Specific requirements for each category are provided in the referenced regulations.

The shipment of Low Specific Activity (LSA) and Surface Contaminated Objects (SCO) is to be conducted in accordance with the requirements specified in 49 CFR 173.427. Persons desiring to ship using these relaxed rules must ensure their material meets the definition of either LSA or SCO

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Appendix H
Guidance for Construction Contractor Use of Radioactive Sources

Industrial Radiography

- A copy of the construction contractor's radiography license shall be included with the health and safety plan (HASP) or otherwise provided to the RSO.
- The HASP for the radiography activity must demonstrate specific knowledge about the planned shots, how they will be conducted safely, and what coordination issues might exist (i.e. impact on GRC employees or other construction contractors working in the nearby vicinity.)
- The HASP should include a diagram or map showing the location of the 2 millirem per hour isodose line. Assumptions used in establishing this boundary should be identified in the HASP or its attachments.
- Areas that need to be evacuated during the radiography shots along with how such areas are to be secured must be identified in the HASP. Coordination with other workers may involve working with the appropriate building manager or the construction manager. Industrial radiography is commonly performed on off-shifts or over the weekend.
- Any other necessary special controls to be implemented during radiography activities must be described in the HASP.
- The HASP should list emergency contact numbers for the contractor's RSO and the Glenn RSO (dispatch)
- The radiographer must comply with all conditions of their radiography license. Required records (training, procedures, license, etc.) must be available to GRC personnel when the contractor is on site.

Portable Gauge Use

- A copy of the construction contractor's radioactive materials license shall be included with the health and safety plan (HASP) or otherwise provided to the RSO.
- The HASP should include the following elements:
 - If needed, consideration of how the gauge activities might impact GRC employees or other construction contractors working in the nearby vicinity.
 - A description of any necessary controls to be implemented during gauging operations.
 - Emergency contact numbers for the contractor's RSO and the Glenn RSO (dispatch)
- In addition, emergency and operating instructions should be kept with the gauge at all times
- If damaged, stolen, or lost the contractor must contact the GRC Radiation Safety Officer and their company's RSO immediately
- The following are radiation safety and source security actions that will prevent access by unauthorized personnel and minimize radiation exposure to members of the public:
 - Physically watch the gauge when it is in use
 - Never leave the gauge unattended when not in use
 - Store it in a locked area
 - At field locations, lock the gauge in the trunk of a vehicle, or secure with a lock and chain if the gauge is kept in an open truck bed

EPM Chapter 28, Radiation Protection for Radioactive Materials
Appendix I
Guidance for Radioactive Waste Management Procedures

General Guidelines

- All radioactivity labels must be defaced or removed from containers and packages prior to disposal in ordinary (non-radioactive) waste. If waste is compacted, all labels that are visible in the compacted mass must be defaced or removed.
- Remind workers that non-radioactive waste such as leftover reagents, boxes, and packaging material should not be mixed with radioactive waste.
- Occasionally monitor all procedures to ensure that radioactive waste is not created unnecessarily. Review all new procedures to ensure that waste is handled in a manner consistent with established procedures.
- In all cases, consider the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and costs.
- Waste management program should include waste handling procedures for the users within their laboratories or assigned areas, and for waste handlers who may collect waste from areas of use to bring to the storage area for eventual disposal.
- Housekeeping staff should be provided adequate training to avoid the possibility of unauthorized disposal or exposure of these individuals to radioactive materials or to radiation.

Model Procedure for Disposal by Decay-in-storage (DIS)

- Only short-lived waste (physical half-life of less than or equal to 120 days) may be disposed of by DIS.
- Short-lived waste should be segregated from long-lived waste (half-life greater than 120 days) at the source.
- Waste should be stored in suitable well-marked containers, and the containers should provide adequate shielding.
- Liquid and solid wastes must be stored separately.
- When the container is full, it should be sealed. The sealed container should be identified with a label affixed or attached to it.
- The identification label should include the date when the container was sealed, the longest-lived radioisotope in the container, date when ten half-lives of the longest-lived radioisotope will have transpired, and the initials of the individual who sealed the container. The container may be transferred to the DIS area.
- The contents of the container should be allowed to decay for at least 10 half-lives of the longest-lived radioisotope in the container.
- Prior to disposal as ordinary trash, each container should be monitored as follows:
 - Check the radiation detection survey meter for proper operation.
 - Survey the contents of each container in a low background area.
 - Remove any shielding from around the container.
 - Monitor all surfaces of the container.
 - Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e., surface readings are indistinguishable from background.
 - If the surveys indicate residual radioactivity, return the container to DIS area and contact the RSO for further instructions.
- If the surveys indicate no residual radioactivity, record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

Model Procedure for Disposal of Liquids In to Sanitary Sewerage

- Confirm that the liquid waste being discharged is soluble or biological material that is readily dispersible in water.
- Calculate the amount of each radioisotope that can be discharged by using the information from prior, similar discharges and the information in 10 CFR 20, Appendix B.
- Make sure that the amount of each radioisotope does not exceed the monthly and annual discharge limits specified in 10 CFR 20.2003(a)(4) and 10 CFR 20, Appendix B.
- Record the date, radioisotope(s), estimated activity of each radioisotope, location where the material is discharged, and the initials of the individual discharging the waste.
- Liquid waste should be discharged only via designated sinks, toilets or release points.
- Discharge liquid waste slowly to with water running from the faucet to dilute it.
- Survey the sink and surrounding work surfaces to confirm that no residual material or contamination remained in the sink or on work surfaces.
- Prior to leaving the area, decontaminate all areas or surfaces, if found to be contaminated.
- Maintain records of each radioisotope and its quantity and concentration that is released into the sanitary sewer system.