Glenn Research Center, Environmental Programs Manual

Radiation Safety Guides

DESCRIPTION OF THE IONIZING RADIATION PROTECTION PROGRAM

DOSIMETRY PROGRAM

EMERGENCY PROCEDURES FOR INCIDENTS INVOLVING RADIOACTIVE RELEASES OR SPILLS

MEDICAL MONITORING

PROCEDURES FOR OPENING PACKAGES CONTAINING RADIOACTIVE MATERIAL

PERSONNEL DECONTAMINATION

PORTABLE GAUGE SAFETY AT CONSTRUCTION SITES

RADIATION DOSE LIMITS

RECEIVING RADIOACTIVE MATERIALS PACKAGES

TRANSPORTATION OF RADIOACTIVE MATERIAL

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DESCRIPTION OF THE IONIZING RADIATION PROTECTION PROGRAM

This section gives a general description of the uses and locations of ionizing radiation sources and equipment that are regulated and monitored by the Radiation Protection Program. The guides and recommendations provide information for radiation source users to protect themselves and others, and comply with radiation safety regulatory requirements. The Program evolves and changes with the uses specific to Glenn and Plum Brook, and all applicable regulatory compliance revisions. The Health Physics Team is available for consultation during the initial planning stages of radiation source use. This will ensure that the appropriate administrative, engineering and other controls can be implemented without significant negative impacts to schedules or costs.

The NASA Glenn Radiation Protection Program maintains and preserves the health of employees through the application of health physics controls. The program requirements and functions are established to eliminate the potential for accidents that can cause personnel exposures, resulting from the use of radioactive materials, sources and ionizing radiation producing equipment. The program is applicable to all occupational radiation workers and non-occupational workers who use or handle radioactive materials. The program procedures maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas, **A**s **L**ow **A**s **R**easonably **A**chievable (**ALARA).**

The Radiation Protection Program covers the use, storage and maintenance of radioactive materials and sources at Glenn Research Center and Plum Brook Station. There is a sealed source inventory that is maintained at Glenn and used primarily for instrument calibration, by both Glenn and Plum Brook, and for some research applications. The sources are stored and secured in the health physics area, in Building 49. The instrument calibration facility is supervised and maintained by the HPT. Radiation survey instruments are calibrated quarterly and after any maintenance or repair procedures are performed.

The Cyclotron Facility was a particle accelerator, located in Building 140, adjacent to Building 49. This facility was operated by the Cleveland Clinic for cancer research and patient treatments, until the shutdown in 1990. At that time, NASA management made the decision to allow the facility to decay under safe storage conditions. The Health Physics Team (HPT) monitors the facility, with periodic direct radiation surveys and surface smears. Residual activation products are Cobalt-60 (activation of nickel), Manganese-54 (activation of iron), Sodium-22 (activation of aluminum), Zinc-65 (activation of copper). The Cyclotron area is a restricted area, with controlled access, and will be released for unrestricted use in approximately 50 years.

Glenn has a medical diagnostic x-ray facility, and research facilities that use diffraction and fluorescence processes. The Glenn Radiographer performs radiographic procedures, with portable x-ray units, and contractor organizations use an Iridium source.

Plum Brook Station, in Sandusky, Ohio, is the location of the research reactor. The decommissioning process has begun for the reactor site, and is scheduled to be completed by 2007. The Radiation Safety Officer has oversight responsibilities for radiation safety requirements. Plum Brook reactor project management staff and contractor personnel are responsible for the on-site health physics and construction work related to the decommissioning activities.

There are very few locations at NASA Glenn where magnetic fields require special shielding or individual monitoring. Building 16 has an Electromagnetic Interference (EMI) test facility, which is shielded. The frequency range is 20 Hertz to 18 Gigahertz, and has a restricted area posting at 1 Gauss, which is the occupied area limit for individuals with pacemakers and other medical devices that are sensitive to magnetic fields.

Other electromagnetic and radio frequency field measurements, taken near power lines, office equipment, transformers, communications equipment, etc. were below the limits specified for potential adverse health effects.

Audits and inspections are conducted to identify areas of non-compliance and improvement, and to provide an overall assessment of the effectiveness of the program.

DOSIMETRY PROGRAM

Personnel Dosimetry

Occupational radiation workers are assigned a permanent personal dosimeter with a number and code for the type of radiation they will be exposed to, until their work with ionizing radiation is terminated. When a new occupational worker enters the NASA Glenn Radiation Protection Program, that individual is required to provide a record of occupational dose from previous employment. Dose received at the previous location will be deducted from the annual exposure allowed at Glenn. For example, if a new radiation worker has received 3 Rem at the previous place of employment, for January through June, they will only be allowed another 2 Rem for the monitoring period, June through December, at Glenn. The annual dose limit for occupational radiation workers is 5 Rem per year. Annual individual exposure reports are issued annually, for the monitoring period, January through December.

Temporary monitoring devices are issued to transient personnel who may be assigned short-term work in a radiation area. The Health Physicist will evaluate the radiation area and assign monitoring devices as appropriate. Individual exposure reports for these workers are issued when their work assignment has been completed.

Dosimetry devices that allow individuals to monitor their daily or hourly exposures are also available. Depending on the level and source of radiation being used, some individuals may be required to use pocket dosimeters and record daily readings.

Dosimetry Investigations

If a personal monitoring device is lost, damaged or irradiated while not in use, the Radiation Safety Officer will conduct an investigation to determine an accurate way to assign dose for the worker whose monitoring device is in question. The worker may be assigned the highest dose received by a co-worker, who performs the same or similar duties in the same radiation area, for the same monitoring period. Depending on the circumstances, a worker may be assigned the highest dose allowable for the quarter, to ensure that the annual dose limit is not exceeded.

Occupational radiation work may have an ALARA that is established much lower than the 5 Rem dose limit, depending on the source and how it is being used. Excessive exposures in these cases will also be investigated.

To avoid inaccuracies in recorded exposures:

1.) Wear your dosimeter as specified for the work being performed
2.) Know where your dosimeter (s) is at all times
3.) Use only the dosimeter assigned to you
4.) Use your assigned dosimeter only at NASA Glenn Research Center, or Plum Brook Station, and only in the areas for which it was assigned
5.) Consult with the Health Physicist or Radiation Safety Officer to determine the correct body location for proper geometry for the field of exposure

6.) Secure your dosimeter in the work area when not in use
7.) Never intentionally irradiate your dosimeter to check the accuracy of the radiation safety process
8.) If you have a medical procedure requiring the use of a radioactive tracer, do not wear your dosimeter until the tracer has dissipated

All discrepancies should be brought to the attention of the Health Physicist and reported to the Radiation Safety Officer for resolution.

Monthly dosimetry reports are on file in Building 49, Room 5.

EMERGENCY PROCEDURES FOR INCIDENTS INVOLVING RADIOACTIVE RELEASES OR SPILLS

All emergencies in areas where radioactive materials are being used shall be reported by dialing **911 Glenn Dispatch**.

PROCEDURES FOR FIRST RESPONDERS:

Emergency Procedures for Radioactive Spills/Releases

- 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 HEALTH PHYSICS TEAM:

- 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

The following radioactive materials, are located in Building 49 and would create a high level exposure hazard in an emergency situation:

Americium-241
Cesium-137

MEDICAL MONITORING

A baseline medical examination should be given to all new occupational radiation workers. A baseline medical examination will establish the condition of the individual before they began work with ionizing radiation sources or equipment.

These examinations are not currently enforced at Glenn because of the extremely low potential risk of exposure to sources of radiation that would produce biological changes in occupational workers. Medical examinations are required; if an unusual incident involving radiation exposure occurs.

Plum Brook reactor decommissioning workers are required to have a baseline medical examination before beginning work at the reactor site.

PROCEDURES FOR OPENING PACKAGES CONTAINING RADIOACTIVE MATERIAL

Shipping packages containing radioactive material or sources must be surveyed within **3 hours** of receipt during regular working hours ***(NASA Glenn does not have an after hours shipping and receiving process.)*** For facilities with shipping and receiving services after regular working hours, the survey must be done within 18 hours of delivery.

Procedures for Health Physics Staff ONLY:

-Use gloves when handling packages

-Measure direct radiation at 1 meter from the surface of package
10 mR/h or more – Call RSO immediately
200 mR/h – DO NOT OPEN

-Open outer package and remove packing slip

-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

Record all survey measurements and information

PERSONNEL DECONTAMINATION

Procedures for decontaminating a person, who has been exposed to radioactive contamination, should be done by or under the supervision of an experienced radiological procedures specialist. 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

3.) Decontamination of wounds should be done under the supervision of a physician

4.) Skin areas that are contaminated should be lathered for **3 minutes and repeated 3-4 times**

5.) After the decontamination process has been completed, the individual should take a thorough shower, giving special attention to the hair, hands and fingernails

PORTABLE GAUGE SAFETY AT CONSTRUCTION SITES

Construction engineering companies often use portable density gauges, containing radiation sources, usually Cesium-137 or Americium-241. These gauges are used to measure the density and composition of surfaces. Cesium sources are generally 10 millicuries (mCi), and Americium sources are approximately 50 mCi in strength. These are substantial quantities when unshielded.

Gauge users are required to have a radioactive materials license, which carries with it the requirement for a designated radiation safety officer. The designated radiation safety officer may have little or no background in radiation safety, but this individual is responsible for ensuring that portable gauges are used safely at their facilities and construction sites. Each year there are a number of incidents at construction sites, associated with portable gauges. Heavy equipment used at construction sites can crush or damage the shielding of a carelessly unattended gauge in such a way that the source is exposed or dislodged.

Portable gauges use two methods of measurement, direct transmission and the backscatter or reflected radiation measurement. For direct transmission, the source is inserted in an opening in the surface to be measured and radiation is transmitted to the gauge detector, which determines the density. The backscatter method sends direct radiation under the surface and the detector measures the reflected radiation. Personnel protective devices are required during operation.

The following are radiation safety and source security actions that will prevent access by unauthorized personnel and 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
-Secure with a lock and chain if the gauge is kept in an open truck bed
-Emergency and operating instructions should be kept with the gauge at all times
-If damaged, stolen, or lost contact the Glenn Radiation Safety Officer immediately

RADIATION DOSE LIMITS

The U. S. Nuclear Regulatory Commission has established dose limits based on the recommendations of the National Council on Radiation Protection & Measurements.

Occupational Annual Dose Limits

5 Rem	Whole body, arms above elbow, legs above knee
50 Rem	Arms below elbow, legs below knee
50 Rem	Skin
15 Rem	Lens of the eye

Members of the Public Annual Dose Limit

0.1 Rem
0.01 Rem - **Under Age 18**

Embryo & Fetus Dose Limit – **Entire Gestation Period**

0.5 Rem

Female Occupational Radiation Workers

Female radiation workers and their supervisors are required to receive special instructions on the potential health risks of prenatal radiation exposure. Contact the Radiation Safety Officer for the required training session.

Biological Effects of Total Body Radiation Exposure

5 Rem – No detectable Symptoms

100 Rem – Nausea/vomiting, drop in production of new blood cells

350 Rem – Requires **immediate** medical attention
- Nausea/vomiting, short-term recovery
- Within 30 days shows signs of susceptibility to infections and bleeding

Exposures higher than 350 Rem CAN BE FATAL!

RECEIVING RADIOACTIVE MATERIALS PACKAGES

The following procedures are guidelines for the NASA Glenn staff who will be processing the receipt of packages containing radioactive material.

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

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.

It is MANDATORY to notify the Health Physics Team within **3 hours** of delivery of a package containing radioactive material or sources.

Contacts are: Christopher Blasio – 3-6520
Gayle Reid – 3-3173 – Pager: 549- 2087

Always contact the Health Physics Team **FIRST** regardless of to whom the package is addressed. A member of the Health Physics Team will pick-up the package and notify the addressee after all license and regulatory requirements have been met.

Do a visual inspection of the package and if it is damaged in any way contact the Radiation Safety Officer **immediately**.

Damage means: **package is wet, the seal is broken, holes, snags, tears, crushed**

If the package is damaged, **DO NOT ALLOW THE TRANSPORT VEHICLE TO LEAVE** until the Health Physics Team surveys the vehicle and personnel for radioactive contamination.

Keep other workers away from the area where the package is located and **DO NOT** move the package.

LABELS

Regulations require all radioactive materials packages to be identified by one of the following labels:

Radioactive WHITE - I – Almost no detectable radiation on outside of package

Radioactive YELLOW – II - Low levels of detectable radiation on outside of package (1 mR/hour 3 feet from surface)

Radioactive YELLOW – III – High levels of detectable radiation on outside of Package (10 mR/hour 3 feet from surface)

TRANSPORTATION OF RADIOACTIVE MATERIAL

Type A Quantities

The U. S. Department of Transportation 49 CFR 172.704 (a)(2) states that employees are required to receive HAZMAT training that is function-specific, every 3 years. The Department does not state who or what the qualifications of the person doing the training should be.

10 CFR 71.5 (b) states that if U. S. Department of Transportation (DOT) regulations are not applicable to a shipment of licensed radioactive material, the licensee is required to comply with the DOT regulations, in 10 CFR 71.5 (a), which says that licensees who transport licensed material to a location outside of the site where it is being used, shall comply with the **applicable** requirements in 49 CFR Parts 170-189.

The guidance in the above requirements can be outlined as follows:

1.) License Documentation Requirements
2.) Container Documentation Requirements
3.) Container Labeling
4.) Material Loading
5.) Survey Requirements
6.) Shipping Paper Requirements
7.) Other Requirements **(May vary because of the physical form of the radioactive material)**

10 CFR 30.41
Requires the NASA Glenn or Plum Brook Station (NASA) to have a copy of the receiver's license or a certification letter, verifying authorization to receive radioactive material. If a licensee gives a specific destination, **DO NOT** ship the material to another location.

If the receiver is licensed by the U. S. Nuclear Regulatory Commission (NRC) to use radioactive material in a state where the NRC has jurisdiction and the specific destination is in an agreement state, NASA is required to request a copy of the reciprocity letter. This also applies when the destination state is not the licensing state of the receiver accepting the radioactive material.

Shipping containers must be certified for the physical form of the radioactive material being shipped. Container certification records must be retained by NASA for 1 year after the last use of the container.

References: 173.410 (i) (3)
173.412 (k) (3)
173.415 (a)
173.466

Container design requirements are specific to the mode of transportation.

Reference: 173.475 (a – f)

Regulations do not require surveying containers for contamination before use. However, if **prior use is not known**, a survey of the **inside** and **outside** is highly recommended. If there are dents, scratches, breaks or nicks that may reduce the integrity of the container or distort labels, it should **NOT** be used.

Container marking requirements are referenced in **172.300-338.** The NASA's name and address are not always required but should always be included. Over-packing must be labeled with the wording, "**This package contains U.S. Department of Transportation 7A Type A Container**". Inner containers must also be labeled.

Survey all containers at 1 meter from surface and at contact of surface. If radiation levels at contact and 1 meter are different, the highest-level label is required.

Container surface contamination limits:

2200 dpm/100 sq. cm - (direct radiation)
6600 dpm/300 sq. cm - (removable)
600 dpm/300 sq. cm - (alpha emitters)

The Transportation Index (TI) is the number that represents the highest level of radiation measured at 1 meter from the surface of the shipping container. There is no maximum transport index. If the TI is more than 10, or the surface radiation level is more than 200 millirem/hour, the package can be label "Exclusive Use". The following 49 CFR parts cover the restrictions for surface radiation levels and "exclusive use" containers.
References: **173.403 - TI**
173.441 - Exclusive use shipments

A security seal is required for all Type A containers. A wire seal that cannot be accidentally damaged or tampered with is recommended. The seal's identification number must be recorded on the shipping papers.

DEFINITIONS

Agreement State – A state which is authorized by the NRC to license and regulate the use of radioactive materials

Limited Quantity – Ratio is less than 0.001, and less than 0.0001 for liquids

Type A Quantity – Radiation levels at the surface of the container or package is 0.5 millirem/hour or more

Type B Quantity – Sum of the ratios for each radionuclide in the container divided by the limits listed in **173.435** is greater than 1

Transportation Index (TI) – An assigned number, which represents the radiation levels at 1 meter from the surface of a shipping container or package

Regulations require all radioactive materials packages to be identified by one of the following labels:

Radioactive WHITE – I
Radiation level at the surface = 0.5 millirem/hour

Radioactive YELLOW – II
Radiation level 3 feet from the surface = 1 millirem/hour

Radioactive YELLOW – III
Radiation level 3 feet from the surface = 10 millirem/hour

Type A containers require two white or yellow labels listing the class, number, radionuclide, activity and TI. Container labeling requirements are found in 49 CFR 172.403. For mixed radionuclides, consult 173.433 (f). The activity must be given in **metric units (Becquerels)**. Curies can be in parentheses after the metric units.

If the container also has a chemical hazard (mercury, asbestos, etc.), two labels listing the chemical must also be applied. **DO NOT list the poison class number** on the chemical labels.

If a container is over packed, the label can state "MIXED" or list all the contents. For soft over packs, for containers with several packages, add the individual package TI's and list the total as the TI for the container. For rigid over packs, the TI for the container can be determined by adding the TI's of the contents, or by a direct radiation survey of the outside surface of the container [**Reference: 173.448 (g)**].

The type of container being used must be listed on the shipping papers.
Example: USDOT 7A TYPE A
Example for Over Pack: "USDOT 7A Type A container inside a metal 55-gallon drum over pack"
The total TI number for all packages cannot exceed 50. This limits the vehicle operator's radiation exposure. A 2 millirem/hour distance applies to any occupied space in the vehicle.

Delivery information must include:
- Name
- Address
- Telephone Number
- Return Address
- List of any transportation restrictions must also be indicated on the form

The contents description on the form must include:

Shipping Name (exactly as it appears in the "Hazardous Materials" Table – **Reference: 172.202 (b)**
UN Number
Class
Radionuclide(s)
Activity
Physical Form
Chemical Form

For **Normal Form** radioactive material, the correct contents information is:
"Radioactive Material, n.o.s., Class 7, UN 2982"
The activity of all radionuclides representing 95% of the hazard must be listed in the contents description **Reference: 173.4 (f)**

NOTE: Activated Materials
Gamma spectrometry will not detect the presence of low energy beta and gamma emitters. For instance, the amount of Iron-55 would have to be calculated based on the amount of Iron-59 and Cobalt-60.

List the physical and chemical form. The quantity of the chemical form must be listed, such as, "5 grams solid activated **(chemical name)** inside an activated **(chemical name)** capsule."

Be sure that shipping papers are CLEAR & LEGIBLE. They must be retained until license termination.

Certification stated that are applicable to the shipment are referenced in **172.204**. A carrier can also be the shipper, in which case, a certification is **NOT** required.

Hazard Communications, Emergency Response & Accidents

When hazardous materials and non-hazardous materials are being shipped together, the shipping form must have an "X" or "RQ" (as applicable) in the Hazardous Materials (HM) column. This column will serve as a hazcom for the transporter or emergency responders in case of an accident.

Emergency response instructions must be attached to the shipping papers and include:

Emergency Telephone Number (Person knowledgeable about the hazards associated with the shipment)
Specific Written Instructions (About the material including its half-life)

The instructions must be clearly stated to help the carrier avoid actions that might delay the delivery, increase radiation levels or radiation exposure to transport workers or member of the public. The shipper is responsible for the required signs, labels and placards.

References:

171.15
172.101
172.200-205
172.441 (c)
172.506
172.604

The shipper is the responsible organization or company, NOT the organization that wants it shipped. If a contractor organization or a carrier prepares the shipment, that contractor or carrier is the shipper and is the responsible party.

References for legal requirements for air shipments are:

l75.441 (d)
175.448 (e)
175.448 (f)
175.702

Transportation accident instructions should include the following information:

1.) Is the radioactive material an immediate threat to the lives of the emergency responders

2.) Is special protective clothing required

3.) Is the radioactive material also toxic or corrosive

4.) What are symptoms of exposure to the material

5.) Are survey and detection instruments required, if so, what are they

6.) What type of radioactive contaminants does the material emit (alpha, beta, gamma), and list cautions for them

Example: Serious radiation hazard if inhaled or ingested