Document Number: GLM-QS-1800.1-8

Revision: Revision J

Effective Date: **07/28/14**

Expiration Date: 07/28/19

Occupational Health Programs Manual – Chapter 8

Radiation Protection for Radioactive Materials w/Change 1 (9/30/2015)

Approved by: QS/Acting Chief, Safety and Health Division

Distribution: BMS Library

NASA - Glenn Research Center
Cleveland, OH 44135

Printed copies are uncontrolled and are not to be used for operational purposes.

Change Record

Rev.	Effective Date	Expiration Date	C-25, Change Request #	Description
H	12/21/2011	12/21/2016	315-G	Inclusion of verification blocks. Addition of requirements for use of nuclear gauge. Process improvements. Incorporation of organizational changes.
I	5/5/2014	5/5/2019	13-001	Reformatted into new template and new numbering protocol. Updates to reflect org changes. Expanded dose requirements to include possibility of internal dose. Expanded contamination discussion to include volumetric and airborne contamination. Added other mechanisms for "Use Authorization" involving RAM. Expanded scope of possible construction activities involving RAM to include handling of RAM, such as from D&D project. Added definitions and acronyms to support updates. Updated guidance for decontamination to reflect collection of materials. Simplified "unrestricted use" contamination limits to more restrictive condition for equipment/building surfaces. Added discussion for airborne contamination control.
J	7/28/2014	7/28/2019	14-012	Clarify internal dose monitoring requirement. Update volumetric contamination reference.
Change 1	9/30/2015	7/28/2019	N/A	Administrative change to remove hyperlinks.

***Include all information for each revision. Do not remove old revision data. Add new rows to table when space runs out by pressing the tab key in the last row, far right column.*

Contents

1.0 PURPOSE....5
2.0 APPLICABILITY....5
3.0 BACKGROUND....5
4.0 POLICY....5
5.0 RESPONSIBILITIES....5
5.1 Occupational Radiation Worker....5
5.2 Supervisor of Occupational Radiation Worker....6
5.3 User of Generally Licensed Device....6
5.4 Radiation Safety Officer (RSO)....6
5.5 Health Physics (HP) or Radiation Protection (RP) Staff....6
5.6 Authorized User....6
5.7 Safety Committee Chairperson....6
5.8 Shipper of RAM....6
5.9 Receiving Department Personnel....6
5.10 Medical Director, Occupational Medicine Services....6
5.11 Human Capital Development Division Chief....6
5.12 Safety and Health Division (SHeD) Chief....6
5.13 Occupational Health Branch (OHB) Chief....7
5.14 Manager, Support Service Contractor Responsible for Maintenance and Operation of Institutional Facilities....7
5.15 Chiefs of the Facilities Division's Branches Responsible for Operations, Project, and Systems Management Functions....7
5.16 Support Service Contractor Supervision....7
6.0 REQUIREMENTS....7
6.1 Training and Qualifications (*NPR 1800.1, 10 CFR 19, 49 CFR, Subpart H, IATA Dangerous Goods Regulations (DGR), and GRC's RAM License*)....7
6.1.1 User of RAM Not Covered by General License....7
6.1.2 User of RAM within a Generally Licensed Device....8
6.1.3 Industrial Radiographer Using RAM....8
6.1.4 Transportation of RAM....8
6.1.5 Receipt of Radioactive Material....9
6.2 Medical Surveillance (*NPR 1800.1*)....9
6.3 Dosimetry and Dose Limits (see Appendix C for detailed guidelines) (*NPR 1800.1, 10 CFR 20.1502, 10 CFR 20.1301, 10 CFR 20.1101*)....9
6.3.1 Dosimetry Assignment....9
6.3.2 GRC Individual Dose Limits....9
6.3.3 Internal Dose Assessment....10
6.3.4 Administrative Dose Limits and Dose Investigation....10
6.3.5 Dose Reports....10
6.4 Contamination Control (*10 CFR 20*)....11
6.4.1 Surface Contamination....11
6.4.2 Volumetric Contamination....11
6.4.3 Airborne Contamination....11
6.4.4 Other Contamination....11
6.5 Radiological Surveys of Sources, Equipment, and Facilities (*10 CFR 20*)....11
6.6 Material Receipt and Accountability (*10 CFR 20 and 10 CFR 30*)....12
6.6.1 Planning and Preparing for a RAM Acquisition....12
6.6.2 Receipt of Labeled Packages of RAM....12
6.6.3 Receipt of Non-labeled Packages of RAM.... **Error! Bookmark not defined.**
6.6.4 Logging and Taking Inventory of RAM....13
6.7 Storage and Control of RAM *(10CFR20.1801 & 1802, 10CFR30.34(i))*....13
6.7.1 General....13
6.7.2 Security Requirements for the Portable Moisture/Density Gauge....13

6.8 Authorization of RAM Uses and Users (*NPR 1800.1*) 14
6.8.1 Use Authorization Processes 14
6.8.2 RSO Approval of RAM Activities and Users 14
6.8.3 Safe Use of Radionuclides and Emergency Procedures 14
6.9 Postings, Signage, Notifications, and Labels (*10 CFR 19 and 10 CFR 20*) 15
6.9.1 Postings for Workers 15
6.9.2 Reports to the NRC 15
6.9.3 Area Postings and Controls for Restricted Areas 15
6.9.4 Container Labels 15
6.10 Radioactive Waste Management (*10 CFR 20*) 15
6.11 Transportation of RAM and Wastes (*10 CFR 71, 49 CFR, Subpart H, and IATA DGR*) 15
6.11.1 Transportation Regulations 15
6.11.2 Shipment Coordination 16
6.11.3 Shipment Preparation 16
6.11.4 Transportation of Portable Moisture/Density Gauge in a Government or Private Vehicle 16
6.12 Construction Contractor Activities Involving RAM (*10 CFR 34 and 10 CFR 30*) 16
6.12.1 Onsite Radiography 17
6.12.2 Portable Nuclear Moisture/Density Gauge Use 17
6.12.3 RSO Approval of Onsite Radiography and Density Gauge Use 17
6.12.4 Other Construction Contractor Activities Involving Radioactive Materials 17
6.13 Self-Luminous Exit Signs (*10 CFR 31.5, NUREG 1556-Vol. 16, and NPR 1800.1*) 18
6.13.1 Description 18
6.13.2 Regulatory Licensing for Self-Luminous (or Tritium-Containing) Exit Signs 18
6.13.3 Management of Self-Luminous Exit Sign Inventory 18
6.13.4 Disposition of Signs When No Longer Needed 18
6.14 Smoke Detectors Containing RAM (*10 CFR 30*) 19
6.14.1 Description 19
6.14.2 Licensing and Requirements 19
6.14.3 Disposition When No Longer Needed 19
7.0 RECORDS 19
8.0 REFERENCES 20
APPENDIX A .—DEFINITIONS AND ACRONYMS 21
APPENDIX B .—RADIATION SAFETY OFFICER RESPONSIBILITIES 25
APPENDIX C .—PROCEDURES FOR PERSONAL DOSIMETRY 26
APPENDIX D .—CONTAMINATION CONTROL GUIDELINES 28
APPENDIX E .—SUMMARY OF RADIOLOGICAL SURVEY REQUIREMENTS 30
APPENDIX F .—MATERIAL RECEIPT AND ACCOUNTABILITY 31
APPENDIX G .—EMERGENCY PROCEDURES 33
APPENDIX H .—TRANSPORTATION OF RADIOACTIVE MATERIAL 34
APPENDIX I .—GUIDANCE FOR CONSTRUCTION CONTRACTOR USE OF RADIOACTIVE SOURCES 38
APPENDIX J .—INFORMATIONAL BRIEFING SHEET FOR OVERSIGHT OF RADIOGRAPHIC TESTING 40
APPENDIX K .—GUIDANCE FOR RADIOACTIVE WASTE MANAGEMENT PROCEDURES 42
APPENDIX L .—SELF-LUMINOUS EXIT SIGN PROCEDURES 44

List of Tables

TALE D.1.—MAXIMUM PERMISSIBLE CONTAMINATION LEVELS FOR UNRESTRICTED USE 29

List of Figures

Figure 1.—Transportation Radioactive Material Labels. 13
Figure 2.—Types of Smoke Detectors. 19

Chapter 8—Radiation Protection for Radioactive Materials

Note: *The current version of this chapter is maintained and approved by the Safety and Health Division (SHeD). The last revision date of this chapter was July 2014. The current version is located on the Glenn Research Center intranet within the BMS Library. Approved by the Acting Chief, Safety and Health Division.*

1.0 PURPOSE

This chapter describes the policies, some basic procedures, and radiation protection requirements for the receipt, use, storage, or transfer of radioactive material (RAM) or equipment using such materials. The scope of RAM addressed by this chapter includes the following: radioactive sources and materials covered by United States Nuclear Regulatory Commission (NRC) licenses (general, specific-scope, etc.), radioactive sources and materials not regulated by the NRC, and radioactive waste. Terms and acronyms used in this chapter are defined in Appendix A.

2.0 APPLICABILITY

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

3.0 BACKGROUND

Radiation-generating equipment (RGE) and RAM are used safely throughout the industrial, medical, and research communities. When not properly controlled, however, such ionizing radiation sources 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 RAM and RGE.

4.0 POLICY

The GRC Radiation Protection Programs for RAM and for RGE are designed to maintain and preserve the health of our employees, the public, and the environment 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 RAM or RGE are approved by the Radiation Safety Officer (RSO) via either the materials application process, the health and safety plan process, the laboratory standard operating procedure (LSOP) process, or the safety permit process. Representatives of the Safety and Health Division (SHeD) 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 for RAM is conducted.

In addition to protecting our workers and the environment, the requirements and conditions of GRC's Radiation Protection Program for RAM demonstrate compliance with applicable regulations of the 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).

The GRC shall follow the requirements of NASA Procedural Requirement (NPR) 1800.1C.

5.0 RESPONSIBILITIES

5.1 Occupational Radiation Worker

The occupational radiation worker shall satisfy training and other requirements of this chapter in addition to working in a safe manner in accordance with established procedures for their RAM.

5.2 Supervisor of Occupational Radiation Worker

The supervisor of the occupational radiation worker shall ensure the user of RAM follows established procedures and meets requirements specified in this chapter and in any applicable safety permits. Also, for Support Service Contractors (SSC), supervisors may be required to maintain medical surveillance and training records.

5.3 User of Generally Licensed Device

The user of a generally licensed (GL) device shall follow the manufacturer's conditions established for the general license (GL) and the applicable local-level procedures for the device, and shall satisfy any training requirements identified by the RSO.

5.4 Radiation Safety Officer (RSO)

The RSO shall ensure activities involving RAM are conducted in accordance with applicable NRC, OSHA, DOT, IATA, and NASA requirements. See Appendix B for detailed responsibilities.

5.5 Health Physics (HP) or Radiation Protection (RP) Staff

For the purposes of this chapter, the identifiers of HP and RP are considered synonymous and concerned with "radiation protection" associated with handling and working with RAM. HP/RP staff support the RSO and are responsible for implementation of many parts of this program was well as other health physics procedures.

5.6 Authorized User

The authorized user (AU) shall supervise the use of licensed RAM, shall ensure that RAM used in his or her particular lab or area are used safely and according to regulatory requirements, and shall ensure that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA. Those designated as AUs are identified on the Center's NRC RAM license.

5.7 Safety Committee Chairperson

The safety committee chairperson shall lead safety permit evaluations and provide guidance to the safety permit requester on how to satisfy permit conditions. In cases involving RAM, the safety committee chairperson shall include the RSO as an ad hoc member of their evaluation committee.

5.8 Shipper of RAM

The shipper of RAM shall ensure that shipments of RAM satisfy current DOT and IATA regulations pertaining to the shipment of hazardous materials and shall satisfy DOT and IATA training requirements.

5.9 Receiving Department Personnel

The receiving department personnel shall be aware of their role in the receipt and accountability procedures for RAM, including notifying the RSO (or SHeD health physics representative) when "labeled" RAM packages are received.

5.10 Medical Director, Occupational Medicine Services

The Occupational Medicine Services Medical Director shall provide medical surveillance and post-exposure evaluation, as well as follow-up actions, in accordance with NASA Procedural Requirement (NPR) 1800.1. Records from such examinations and evaluations shall be retained for at least 30 years. Results of examinations shall be discussed with employees as needed. For SSC, such records may alternately be maintained by the employer.

5.11 Human Capital Development Division Chief

Maintain records for employee completion of radiation safety courses and any associated examinations. For SSC, such records may alternately be maintained by the SSC supervision.

5.12 Safety and Health Division (SHeD) Chief

The SHeD chief shall support the RSO and safety committee chairpersons in the performance of their duties.

5.13 Occupational Health Branch (OHB) Chief

The OHB chief shall support the RSO and other Health Physics / Radiation Protection staff in the performance of their duties.

5.14 Manager, Support Service Contractor Responsible for Maintenance and Operation of Institutional Facilities

The manager for SSC responsible for maintenance and operation of institutional facilities will maintain and manage the inventory of luminous exit signs at their respective location per requirements in this chapter, including Appendix L.

Also, the manager will provide smoke detector heads containing RAM to the RSO or Code FE waste management personnel when these devices have been taken out of service and are no longer needed.

5.15 Chiefs of the Facilities Division's Branches Responsible for Operations, Project, and Systems Management Functions

The Chiefs of the Facilities Division's Branches Responsible for Operations, Project, and Systems Management Functions shall support management of luminous exit sign inventory per requirements in the chapter and in Appendix L.

Also, they shall provide smoke detector heads containing RAM to the RSO when these devices have been taken out of service and are no longer needed.

5.16 Support Service Contractor Supervision

If applicable, maintain records for employee completion of radiation safety courses and any associated examinations as well as records of any medical evaluations or examinations triggered because of potential exposure to ionizing radiation.

6.0 REQUIREMENTS

Note: *Many of the activities performed by SHeD health physics staff are described in GRC Health Physics Procedures. The Health Physics Procedures are approved and maintained by the Center's RSO.*

6.1 Training and Qualifications (*NPR 1800.1, 10 CFR 19, 49 CFR, Subpart H, IATA Dangerous Goods Regulations (DGR), and GRC's RAM License*)

6.1.1 User of RAM Not Covered by General License

NASA civil servants and SSCs using radioactive sources and/or materials not included within a generally licensed device, or a device specifically exempt from licensing, shall receive radiation safety training prior to using the RAM and biennially thereafter. Such individuals would be considered to be "occupational radiation workers." This group would include individuals working with radioactive sources and Health Physics (HP) / Radiation Protection (RP) staff supporting this use, as well as other HP/RP activities involving and handling of RAM. This radiation safety training shall be specified by the RSO.

6.1.1 - Employee completion of radiation safety training is documented in SATERN, which is accessible by the reporting function of an administrative SATERN session.

6.1.1.1 Instruction on Prenatal Radiation Exposure

Female radiation workers shall also receive special instruction on the potential health risks of prenatal radiation exposure in accordance with NRC Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure." The RSO shall provide this special instruction and document acknowledgment of such instruction. Any written declaration made by a pregnant employee who is occupationally exposed to ionizing radiation will be maintained on file by the RSO. As necessary, based upon work activities and any potential restrictions, the employee's supervisor may also be provided the subject instruction.

6.1.1.1 - Documentation on prenatal exposure instruction will either be maintained by the RSO, or, be documented in SATERN, which is accessible by the reporting function of an administrative SATERN session.

Written declarations made by pregnant workers will be maintained by the RSO.

6.1.1.2 User of the Portable Moisture/Density Gauge

In addition to the radiation safety training, operators of the portable moisture/density gauge will also satisfy gauge use training as outlined in NUREG 1556, Volume 1, Appendix D.

6.1.1.2 - Employee completion of radiation safety training and gauge use training is documented in SATERN, which is accessible by the reporting function of an administrative SATERN session.

6.1.2 User of RAM within a Generally Licensed Device

As a rule, GL devices are designed to be inherently safe under reasonably expected use scenarios. The user shall be trained to operate their specific equipment per any training and qualification criteria identified in the applicable Business Management System (BMS) or local procedural documents for said activity as well as the relevant safety permit. In addition, radiation safety training may be required by the RSO.

6.1.2 – If required by RSO, employee completion of radiation safety training is documented in SATERN, which is accessible by the reporting function of an administrative SATERN session.

6.1.3 Industrial Radiographer Using RAM

The GRC does not possess an NRC license permitting employees to use radioactive sources for conducting industrial radiography.

Construction contractors conducting radiography activities at temporary job sites on GRC property shall satisfy training and work experience requirements specified by the NRC in 10 Code of Federal Regulations (CFR) 34, Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations. Records of such training and certification shall be made available to the GRC RSO upon request.

6.1.4 Transportation of RAM

Employees performing pre-transportation and transportation functions, as described in 49 CFR 171.1, shall receive initial and periodic training in accordance with Subpart H of the DOT's 49 CFR 172 for hazardous materials and the IATA Dangerous Goods Regulations.

6.1.4.1 RSO and Health Physics Staff / Radiation Protection Staff

The RSO and any HP/RP staff performing functions identified in 49 CFR 171.1 shall receive the training identified above. This training shall be function-specific and relevant and shall be repeated as necessary to satisfy pertinent regulations.

6.1.4.1 – Training and certification records for the RSO and HP staff can be found in either the RSO files or in SATERN. The latter documentation would be accessible via the reporting function of an administrative SATERN session.

6.1.4.2 Shipper of RAM

The employee designated as the shipper of RAM shall receive the training identified above. This training shall be function-specific and relevant and shall be repeated as necessary to satisfy pertinent regulations

6.1.4.2 – Training and certification records for the RAM shipper will be maintained by his SSC supervision. For convenience, the RSO will also attempt to maintain a copy of such records on file.

6.1.4.3 Transportation of Portable Moisture/Density Gauge

Anyone transporting a portable moisture/density gauge in a private or government vehicle shall receive initial and periodic training in accordance with Subpart H of the DOT's 49 CFR 172 for hazardous materials. This training shall be function-specific and relevant and shall be repeated as necessary to satisfy pertinent regulations

6.1.4.3 – Training and certification documentation for employees transporting a nuclear gauge is documented in SATERN, which is accessible by the reporting function of an administrative SATERN session. For convenience, the RSO will also attempt to maintain a copy of such records on file.

6.1.5 Receipt of Radioactive Material

Staff within the Shipping and Receiving organization shall receive guidance from the RSO on their roles for receiving radioactive material. This instruction can take the form of instructional postings in the work area, staff briefings, or other similar methods.

6.2 Medical Surveillance (*NPR 1800.1*)

Radiation medical examinations shall be conducted in accordance with the requirements set forth in NPR 1800.1, NASA Occupational Health Program Procedures. Examination categories include preplacement examinations, periodic reexaminations, 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 of RAM is suspected.

6.2 – Any such medical records would be maintained by Occupational Medicine Services.

6.3 Dosimetry and Dose Limits (see Appendix C for detailed guidelines) (*NPR 1800.1, 10 CFR 20.1502, 10 CFR 20.1301, 10 CFR 20.1101*)

6.3.1 Dosimetry Assignment

The use of personal dosimetry to estimate external radiation exposure may be required for certain uses of RAM. The RSO shall 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 shall assign personal dosimetry to individuals working with RAM who are likely to receive an annual dose in excess of 10 percent of their annual allowable limit or other situations prescribed in Section 20.1502 of Title 10 of the CFR. In practice, workers are typically assigned to use dosimetry at much lower exposure levels.

6.3.1 – The requirement to use dosimetry is typically specified by the RSO as a condition on the safety permit or comparable documentation for other use authorization mechanisms associated with the activity. Radiation dosimetry records are maintained by the RSO or HP/RP staff of the SHeD.

6.3.2 GRC Individual Dose Limits

6.3.2 – Dosimetry results are reviewed by the RSO on at least a quarterly basis to monitor cumulative doses of record for employees participating in the Center's radiation dosimetry program. Assignment of any internal doses are reviewed by the RSO as they are determined.

6.3.2.1 General

Dose limits must actually take into consideration doses from sources of radiation that are both outside the body (external) AND inside the body (internal), which, are referred to as Deep Dose Equivalent (DDE) and Committed Effective Dose Equivalent (CEDE), respectively. This DDE is commonly referred to as the "whole body dose" for external radiation dosimetry. The individual dose limits for DDE and CEDE are both 5 rem, as is the overall occupational dose limit, which is referred to as the Total Effective Dose Equivalent (TEDE). As described, the TEDE=DDE+CEDE and none of the three can exceed 5 rem per year.

The following dose limits shall apply to individuals at GRC for all sources (RAM and RGE) of ionizing radiation:

6.3.2.2 Occupational Annual Dose Limits

- Whole body/deep dose equivalent(DDE), total effective dose equivalent (TEDE), or committed effective dose equivalent (CEDE): 5 rem (0.05 sievert (Sv))
- Lens of eye (lens dose equivalent (LDE)): 15 rem (0.15 Sv)
- Extremities, skin (shallow dose equivalent (SDE)), specific organs: 50 rem (0.5 Sv)

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

- Whole body/DDE, TEDE, or CEDE: 0.5 rem (0.005 Sv)

6.3.2.4 Members of the Public (i.e. non-radiation workers) Dose Rate Limit and Annual Dose Limit (due to occupational radiation sources)

- Non-radiation workers shall not be exposed to an external dose rate where they could receive more than 2 millirem (0.02 millisievert) in any hour.
- Whole body/DDE, TEDE, or CEDE: 0.1 rem (0.001 Sv) per year
- CEDE for any air emissions of RAM to the environment: 0.01 rem (0.0001 Sv) per year

6.3.3 Internal Dose Assessment

Based upon current and foreseeable activities, inhalation is viewed as the potential exposure pathway of interest and air monitoring is expected to provide sufficient information for assigning possible internal occupational dose. Center-level procedures have been developed and will be maintained for Airborne Radioactivity Monitoring, which includes assignment of CEDE from such monitoring. Other methods for internal dose assessment, such as bioassay monitoring or whole-body counting may be used, on a case-by-case basis, if needed. For the purposes of internal dose assessment from inhalation, one (1) Derived Air Concentration-hour (DAC-hour), as determined by personnel monitoring, will represent a CEDE of 2.5 mrem. At a minimum, internal exposure monitoring shall be conducted for adults likely to receive an intake in one year in excess 10% of the applicable Annual Limit on Intake (ALI). For minors and declared pregnant women, internal exposure monitoring is required when intakes are likely to result in a CEDE in excess of 0.05 rem (0.0005 Sv) .

6.3.4 Administrative Dose Limits and Dose Investigation

In practice, worker doses at GRC have historically been well below the stated limits. Administrative occupational dose limits for radiation workers shall be established at 10 percent of the limits in Section 6.3.2. Should a worker's dose for a recording period appear unexpectedly high or, at a minimum, reach this administrative limit (prorated for the recording period), the RSO would initiate an investigation into the cause of the individual's dosimetry results. This 10 percent dose level is established as an administrative dose limit.

6.3.3 – Documentation for the investigations associated with dose results are kept with the individuals' dose records and with the chronological dosimetry reports.

6.3.5 Dose Reports

Annual reports summarizing employees' radiation dose data shall be provided to said employees per requirements set forth in 10 CFR 19.13. Also, participants can, at any time, make such a request. For workers engaged in licensed activities, this report shall contain the following statement (or similar): "This report is furnished to under the provisions of the NRC 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. The request shall be satisfied within a specified timeframe.

6.3.5 – As needed, copies of the reports are kept with the employees' individual dose records.

6.4 Contamination Control (*10 CFR 20*)

6.4.1 Surface Contamination

Improper handling of non-sealed radioactive sources/materials or the loss of integrity of a sealed radioactive source could result in the spread of RAM onto nearby personnel, equipment, and the environment. For most radioisotopes, a relatively small amount of radioactivity is readily detectable (using appropriate instrumentation) 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 D.

6.4.2 Volumetric Contamination

The presence of unwanted radioactivity within a solid matrix, such as concrete or a metal, is termed volumetric contamination. Degrading or otherwise aggressively working on such solid matrices could result in the release of the embedded radioactivity into the environment. Appropriate controls are needed to contain/control this release and protect employees, the general public and environment.

6.4.3 Airborne Contamination

The release of radioactivity into the air results in airborne contamination. Surface and volumetric contamination have the potential to go airborne in certain scenarios. Another source of airborne contamination could be handling or working with unsealed sources or RAM whereby small amounts of any associated loose material could become airborne. Appropriate controls are needed to contain/control such releases and protect employees, the general public and the environment. More specific guidelines are provided in Appendix D.

6.4.4 Other Contamination

Other work circumstances involving potential radioactive contamination will be evaluated on a case-by-case basis with controls and limits established accordingly. One possible scenario could be the need to wear cloth-type protective clothing for a job. Contamination control and limits would become part of the task of managing how said clothing was laundered. A second example could involve a work activity within an established restricted area where surface contamination limits are set as an effort to minimize the spread of radioactivity. The process for reviewing tasks and prescribing necessary controls and conditions would, at a minimum, involve approval of the RSO. Depending upon work control procedures associated with the work tasks, other personnel, such as an independent technical reviewer or a certified health physicist, may also be part of the approval process.

6.5 Radiological Surveys of Sources, Equipment, and Facilities (*10 CFR 20*)

Various radiological surveys shall be conducted periodically to verify that the RAM 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 GL device containing a nuclear source. Surveys may also be performed during or after activities involving RAM to determine the extent of radiological contamination on working surfaces, tools, employees or the air. The RSO shall be responsible for establishing periodicities for radiological surveys supporting activities where RAMs are utilized, handled, or stored. Surveys are documented using a GRC Radiological Survey Form or other form in accordance with health physics procedures. Associated reports or printouts with analytical results will also be kept on file.

Surveys conducted in support of RAM receipt or RAM shipment are specified in Appendix F and Appendix H, respectively.

Other survey requirements are summarized in Appendix E.

6.5 – Documentation for surveys and other radiological analyses is maintained in health physics files.

6.6 Material Receipt and Accountability (*10 CFR 20 and 10 CFR 30*)

6.6.1 Planning and Preparing for a RAM Acquisition

Prior to purchasing or receiving any RAM or devices containing such materials, individuals shall contact the RSO to discuss relevant requirements associated with possessing and using the RAM.

6.6.1.1 Licensing Assessment and Amendment

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

> ***Note:*** *Amendment requests for the Center's NRC materials license can take 2 or more weeks to prepare and submit, assuming all necessary information is available. The NRC could take up to 90 days (or longer) to review and approve the proposed amendment or reply with questions. Receipt of the RAM would not be legally authorized until the RSO has received notice from the NRC. Similarly, the source supplier would not be legally authorized to transfer a non-exempt, licensable source to GRC unless they had a copy of our license demonstrating the possession was authorized.*

6.6.1.1 – Copies of amendment requests and corresponding license modifications are maintained on file by the RSO.

6.6.1.2 Logistic Assessment for RAM Use and Storage

The RSO shall determine if use and storage locations of the device afford adequate safety and security. Facilities shall have adequate shielding characteristics for the radioactive source to meet the exposure criteria specified in 6.3.2.4 and shall enable employees to work with the source(s) safely. The proposed facility shall also allow for adequate control of the RAM.

6.6.1.3 Disposition of Radioactive Source

The RSO shall assess post-use storage and disposal issues associated with the RAM or device.

6.6.1.4 Assessment of RAM Use Requirements

The RSO shall establish needs for worker training, engineering or administrative controls, radiation dosimetry, radiation detection instrumentation, radiological surveys, etc. associated with RAM possession.

6.6.2 Receipt of Packages of RAM

6.6.2.1 Labeled Packages Versus Non-labeled Packages (a.k.a. "Excepted" Packages)

Under Department of Transportation (DOT) hazardous material regulations, RAM above minimal levels is classified as "Class 7" material. Within DOT Class 7, RAM packages will either be "Labeled" or non-labeled. The termed "labeled" refers to the transportation categories of White I, Yellow II, and Yellow III for radioactive sources or RAM (see Figure 1). The radioactivity content in such packages exceeds the levels found in non-labeled conveyances, most commonly "Radioactive material—excepted package…," which is typically for small (i.e. "limited") quantities of RAM or instruments/articles containing smaller radioactive sources.

White I Yellow II Yellow III

Figure 1.—Transportation Radioactive Material Labels.

6.6.2.2 Shipping and Receiving Department

"Labeled" (i.e., White I, Yellow II, or Yellow III) and "Excepted" RAM packages shipped to GRC shall be processed by the receiving department in accordance with Appendix F. Since receipt of such packages is typically coordinated by the RSO, the RSO shall, when feasible, notify receiving department personnel of the estimated arrival date of the expected package. As specified by the RSO, receiving personnel may need to make arrangements for expeditious receipt of certain RAM packages.

6.6.2.3 Health Physics Staff / Radiation Protection Staff

The RSO or other HP/RP staff should notify Shipping and Receiving Personnel when the Center expects to receive a shipment of RAM. This advance notification is required when the expected package contains RAM in excess of a "Type A" quantity, as described in NRC and DOT regulations. The RSO or other SHeD HP/RP representative shall open the package in accordance with Appendix F and good RAM-handling practices, and then process the receipt of the contents per Section 6.6.3.

6.6.3 Logging and Taking Inventory of RAM

6.6.4 – "Radioactive Material Receipt and Inventory Record" forms (C-811), or similar forms, are maintained on file by the RSO. The electronic RAM, or radioactive source, inventory is maintained by the RSO. Semiannual printouts of the physical inventory are maintained on file by the RSO

6.6.3.1 Documenting Receipt of a Radioactive Source or RAM

The RSO or member of SHeD HP/RP staff shall complete a NASA C-811, Radioactive Material Receipt and Inventory Record, or similar form, to be placed in the appropriate RAM file folder along with any shipping or manufacturer's information for the item. In addition, the radioactive source inventory shall be updated. When receiving activated materials or components that contain multiple isotopes, the inventory entry shall identify the item and list the necessary information for each isotope.

6.6.3.2 Movement of Radioactive Sources or RAM

Internal transfers of radioactive sources and equipment shall be coordinated with SHeD HP/RP personnel and shall be approved by the RSO. This notification is necessary to ensure that RAM is appropriately tracked, records are updated, and that any safety and security issues associated with the new location are assessed.

6.6.3.3 Physical Inventory

A physical inventory of licensed, GL, and unlicensed RAM shall be conducted every 6 months by the RSO, HP/RP staff, or other SHeD staff. Upon completion of the inventory, the RSO shall print off the current inventory and place this document in the inventory file.

6.7 Storage and Control of RAM *(10CFR20.1801 & 1802, 10CFR30.34(i))*

6.7 – Proper, secure storage will, at a minimum, be verified during semi-annual inventories.

6.7.1 General

When not in storage, RAM shall be controlled or under constant surveillance by Center staff. When in storage, RAM shall be controlled such that it is secured from unauthorized removal or access.

6.7.2 Security Requirements for the Portable Moisture/Density Gauge

When not under control and constant surveillance, at least two independent physical controls that form tangible barriers shall be used to secure the portable gauge unauthorized removal.

6.8 Authorization of RAM Uses and Users (*NPR 1800.1*)

6.8 – Safety permit documentation is maintained either by the chairperson of the committee issuing the permit or within a safety permit database. LSOP documentation is maintained by the chemical management lead or other Occupational Health Branch personnel. For convenience, the RSO will try to maintain a copy of such paperwork. Any other use authorizations and associated documentation for RAM will be maintained by the RSO.

6.8.1 Use Authorization Processes

6.8.1.1 Safety Permit

SHeD's safety permit process is used as a vehicle for assessing and addressing potential health and safety hazards associated with activities at GRC and, as such, it will be used for most RAM uses. The RSO shall assist area safety committees in determining requirements, controls, and conditions for a safety permit involving the use of RAM. Typical permit conditions could include training, posting and labeling, source security, the use of any personal protective equipment (PPE), necessary engineering controls, the use of radiation dosimetry, periodic radiation surveys, and written operating and emergency procedures. There are certain items containing RAM that could be considered inherently safe, such as certain GL or license-exempt devices, and therefore, require less-stringent use conditions. The RSO shall be responsible for making such a determination and advising the safety committee chair whether or not safety permit conditions were needed to address the use of the RAM-containing device or item.

6.8.1.2 Laboratory Standard Operating Procedure

Depending upon the scope of the work activity, the LSOP process may be used to evaluate the scope and potential hazards of work tasks involving RAM. The RSO shall work with the chemical management or occupational health staff member leading the review and approval of the subject LSOP. The RSO shall be responsible for ensuring that appropriate conditions and other use requirements are established in the LSOP.

6.8.1.3 Other

For instances where a work activity does not fall within the purview of the safety permit or LSOP process, the RSO would evaluate the proposed use and prescribe necessary controls and use requirements.

6.8.2 RSO Approval of RAM Activities and Users

Employees shall satisfy whatever license requirements or use authorization conditions that exist for using the subject RAM. Most operations involving the use of RAM would be covered under the safety permit system, which provides a convenient mechanism (qualified operator's list (NASA C–580) and the safety permit (NASA C–919)) for calling out conditions and qualifications pertaining to use. Since the RSO is a member of the evaluation committee that established the safety permit conditions, such requirements and qualifications related to radiation protection issues shall be considered to be approved by the RSO. The RSO might also be the approving authority on certain site-wide safety permits of limited scope.

For LSOP and other use authorization processes, the RSO's approval of the task is evidenced by their involvement, prescription of controls and approval or, or, concurrence with established procedures.

During such review processes, the RSO shall verify that RAM users had satisfied their initial and refresher radiation training requirements along with any other training or qualification requirements.

6.8.3 Safe Use of Radionuclides and Emergency Procedures

An operating procedure, which describes how and where the radiation source will be used, shall be submitted to the RSO (either directly or via the LSOP or safety permit process). The level of detail of these procedures will vary depending upon the complexity of the activity. Procedures for the use of GL devices containing RAM might only include the manufacturer's instruction manual. For experiments involving radioactive sources, procedures shall be developed which address, in detail, what safety precautions are being taken and how the work will be done safely. These procedures shall be reviewed and approved by the RSO.

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 RAM are summarized in Appendix G.

6.9 Postings, Signage, Notifications, and Labels (*10 CFR 19 and 10 CFR 20*)

6.9.1 Postings for Workers

The following documents shall be posted in areas where licensed RAM 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 that identifies where said documents can be examined).

6.9.2 Reports to the NRC

The RSO shall submit reports to the NRC in accordance with 10 CFR 20.2201to 20.2204 as applicable 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 (10 CFR 20.2205 and 20.2206)

6.9.3 Area Postings and Controls for Restricted Areas

Restricted, RAM, radiation, 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 may be available from the RSO.

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

Smoking, eating, and drinking shall be prohibited in restricted areas.

6.9.4 Container Labels

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.

6.10 Radioactive Waste Management (*10 CFR 20*)

Radioactive wastes generated onsite shall be appropriately stored prior to disposal; shielding, posting or labeling, and security shall be considered. The RSO shall approve of all radioactive waste control procedures and corresponding facilities. Radioactive waste guidelines are provided in Appendix K. Disposal of RAM (liquids, solids, or gas) shall be coordinated with the SHeD HP/RP function and shall be approved by the RSO. The RSO will work with the waste management group and the RAM shipper to ensure license conditions and regulations (NRC, DOT, and EPA) are satisfied.

6.11 Transportation of RAM and Wastes (*10 CFR 71, 49 CFR, Subpart H, and IATA DGR*)

6.10 – Documentation for shipments or RAM or radioactive wastes will be maintained on file by the RSO.

6.11.1 Transportation Regulations

There are three sources of regulations pertaining to the shipment of RAM and wastes:

- DOT: Title 49, Parts 171–185, Hazardous Materials Regulations
- NRC: Title 10, Part 71, Packaging and Transportation of Radioactive Material
- IATA: Dangerous Goods Regulations, Section 10—Radioactive Material

While the rules are somewhat similar, determining the appropriate set to follow depends upon factors such as the type and form of RAM, the amount of activity, the shipping container, and mode of shipment. The DOT probably serves as the regulatory authority for most RAM shipments at GRC. 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 RAM, requirements specified by IATA's *"Dangerous Goods Regulations, Section 10—Radioactive Material"* would also need to be satisfied.

6.11.2 Shipment Coordination

All shipments of RAM and radioactive wastes shall be coordinated by the RSO, or their designee.

Prior to shipment, the RSO shall receive a copy of the prospective recipient's materials licensee to ensure that they are, in fact, authorized to receive the RAM. This license and any supporting documentation must specify that the actual physical location receiving the RAM is authorized to posses 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 SHeD HP/RP representative shall prepare a NASA C–359, Radioactive Shipment Certification Record, in addition to a NASA C–727, Shipping Request Document, and shall provide them to the RAM shipper. This individual shall prepare the paperwork required for type of shipment identified.

6.11.3 Shipment Preparation

Packages for shipment shall satisfy DOT, NRC, and IATA (as appropriate) criteria for the type of shipment planned, and, if required, 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 excepted limited quantities, excepted instruments/articles, low specific activity (LSA) objects, surface-contaminated objects (SCOs), Type A quantities, Type B quantities, and highway route-controlled quantities (HRCQ).

Packaging and shipping of certain materials, such as a Type B source, requires that the packager and shipper of record have a quality assurance (QA) program established per the NRC's 10 CFR 71.20. GRC does not have such a QA program, so any shipments of such materials would have to be packaged and shipped by a representative of an appropriately qualified contractor or by the Department of Energy.

Applicable guidance for the common RAM shipments from GRC is included in Appendix H.

6.11.4 Transportation of Portable Moisture/Density Gauge in a Government or Private Vehicle

When transporting a GRC portable moisture/density gauge in a vehicle on a public roadway (i.e. outside of either Lewis Field or Plum Brook Station), specific requirements must be followed to satisfy DOT and NRC regulations. Operating and emergency procedures associated with gauge use will outline the process to be followed, which includes the following general elements: preparation and labeling of package, driver hazmat training, package security and positioning during conveyance, transportation paperwork (i.e. bill of lading), and receipt inspection. The RSO will approve any such procedures.

6.12 Construction Contractor Activities Involving RAM (*10 CFR 34 and 10 CFR 30*)

6.11 – The RSO maintains copies of the temporary jobsite RT plans and/or Health and Safety Plans that have been approved along with any information that has been provided with the plan request.

6.12.1 Onsite Radiography

Contractors 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 currently used by radiographers. Individuals performing source radiography shall have a radiography license issued by the NRC to perform such work at GRC, a Federal reservation. Alternatively, a state license with a reciprocity agreement from the NRC shall be acceptable. There are strict training and performance criteria and control requirements that must be satisfied to obtain such a license.

6.12.2 Portable Nuclear Moisture/Density Gauge Use

Construction engineering companies may also use portable density gauges, containing radioactive sources, usually cesium-137, americium-241, or possibly radium-226. These gauges are used to measure the density of soil, asphalt or other media. The latter two radioisotopes may be combined with beryllium metal, resulting in a neutron-emitting source that could be used for measuring moisture content in a material such as soil. Gauge users shall have a RAM license issued by the NRC, or alternatively, by a comparable state agency with an NRC reciprocity agreement. Again, there are license conditions that must be satisfied to use such gauges. The construction contractor shall be responsible for the safe use and storage of the density gauge. When not in use, the device should be secured in an area away from heavy equipment to minimize the chance of a construction vehicle accidentally crushing or damaging the shielding such that the source becomes exposed or dislodged.

6.12.3 RSO Approval of Onsite Radiography and Density Gauge Use

Approval for performing the abovementioned activities or other contractor tasks involving RAM shall be obtained via SHeD's Health and Safety Plan (HaSP) process, as described in Chapter 17, Construction Safety, of the Glenn Safety Manual. Alternatively, a "radiation safety plan" (format can vary) may be submitted to the RSO when only radiological hazards posed by the activity. The RSO shall review and approve aspects of the contractor's HaSP or "radiation safety plan" related to using RAM. More specific guidance on these construction activities and RSO approval is provided in Appendix I.

> ***Note:*** *The RSO's "approval" only covers the radiation safety elements of the task.Other industrial safety and environmental concerns should be covered within the HaSP (e.g., scaffolding, working aloft, or disposal of chemicals.) Since, the radiographic testing (RT) or gauge-use contractor is often a subcontractor of another subcontractor, it would probably be appropriate to get them to sign off on the prime contractor's HaSP or get them to issue a letter (on company letterhead) indicating they will abide by the prime contractor's HaSP.*

In addition, during radiographic testing, the NASA organization responsible for bringing in the radiographer shall have a representative onsite for oversight of and coordination with the industrial radiography contractor. Appendix J is provided as an informational guidance document for the on-site NASA (civil service or support-service contractor) representative.

6.12.4 Other Construction Contractor Activities Involving Radioactive Materials

Tasks or projects performed by Construction Contractors involving the use, handling, processing or management of radioactive materials will be assessed on a case-by-case basis. Typically, the "Health and Safety Plan" process, as described in Chapter 17, Construction Safety, of the Glenn Safety Manual, will be used as the vehicle for evaluating a Contractor's proposed work and implementation of necessary elements of NASA's Radiation Protection Program as well as applicable regulations. For a large and complicated project, this implementation could include establishing project-specific plans, procedures and other processes along with a formal NASA oversight mechanism. An example of such an activity could be the decontamination and decommissioning of a radiologically-impacted area or facility. For any such Construction Contractor activities, the NASA RSO will be responsible for organizing, administering and directing Radiation Protect Program elements during project tasks involving NASA's radioactive materials.

6.13 Self-Luminous Exit Signs (*10 CFR 31.5, NUREG 1556-Vol. 16, and NPR 1800.1*)

6.13.1 Description

Self-luminous exit signs found throughout GRC utilize radioactive tritium gas and a phosphorous material to produce light. The type of signage offers an economical and effective means of satisfying life safety codes for occupied buildings. Tritium exit signs pose little or no threat to public health and safety and do not constitute a security risk. However, the NRC requires proper recordkeeping and disposal of these items. Proper handling and recordkeeping are important, because a damaged or broken sign could cause mild radioactive contamination of the immediate vicinity, requiring a potentially expensive cleanup.

6.13.2 Regulatory Licensing for Self-Luminous (or Tritium-Containing) Exit Signs

6.13.2.1 NRC License Type

The subject exit signs are considered GL devices because they are inherently safe enough to be handled or used by anyone with no radiation training or experience. Although purchasers, known as "general licensees," do not need authorization from the NRC to possess the signs, they are subject to certain regulatory requirements (10 CFR Part 31) regarding handling, transfer, or disposal of the signs. They are also subject to NRC inspection and enforcement action (including fines) for violating those requirements.

6.13.2.2 General License Conditions

The general licensee

- Shall assure that they maintain (i.e., not deface or remove) warning and instruction labels provided with the signs and that they comply with stated instructions and precautions on such labels
- Shall immediately suspend use of a sign if there is failure of, or damage to, or indication of possible failure of or damage to the shielding or containment of the radioactive tritium; properly dispose of the broken or damaged sign by transferring to an authorized recipient (i.e., specific licensee); and within 30 days, file an appropriate report to the NRC
- Shall not abandon the GL device
- Shall not export the GL device, except in accordance with NRC export rules
- Shall only dispose of signs by transfer to an authorized recipient (i.e., specific licensee) and within 30 days, file an appropriate report with the NRC
- Shall comply with NRC reporting requirements for radiological incidents or loss/theft of devices
- Shall appoint an individual responsible for having the knowledge of the appropriate regulations and requirements and the authority for taking required actions to comply with appropriate regulations and requirements

6.13.3 Management of Self-Luminous Exit Sign Inventory

Personnel working for the SSC responsible for maintenance and operation of institutional facilities shall be responsible for managing GRC's large inventory of tritium-containing exit signs. Center operations and project management personnel shall be aware of their responsibility to notify and coordinate with the SSC when signs are installed, moved, or taken out of service. Requirements for management of self-luminous exit signs are provided in Appendix L of this chapter.

6.12.3 – Inventories of Exit Signs are maintained by the SSC responsible for Center operations. The RSO will periodically call for this inventory, which will be put on file.

6.13.4 Disposition of Signs When No Longer Needed

Tritium-containing exit signs shall be properly disposed of when they are no longer needed or past their service life. Typically, the signs will be traded-in or otherwise returned to their manufacturer for disposal. The SSC responsible for maintenance and operation of institutional facilities shall contact the RSO who will coordinate this transfer of

signs as described in Appendix L of this chapter. The RSO shall generate the appropriate reports to the NRC per the guidance provided in NUREG–1556, Vol. 16, Appendix L.

6.12.4 – Documentation associated with the transfer of Exit Signs being returned to the vendor or, otherwise, disposed will be maintained as described in the Section on "Transportation of RAM and Wastes."

6.14 Smoke Detectors Containing RAM (*10 CFR 30*)

6.14.1 Description

Certain smoke detectors use small amounts of RAM as part of their particle ionization detection technology. There are two basics types of these units potentially in use at the Center: a low-voltage (and lower activity) version and a high-voltage (higher activity) version. Sample images are provided in Figure 2.

Examples of Low-Voltage Type

High-Voltage Type Examples (two views of internal heads and one view of complete unit)

Figure 2.—Types of Smoke Detectors.

6.14.2 Licensing and Requirements

Possession and use of these ionization smoke detectors are exempt from NRC regulations (10 CFR 30, parts 15 and 20) provided that they are used as intended. Disassembly or alternate uses are not permitted under said exemption.

6.14.3 Disposition When No Longer Needed

Personnel working for the SSC responsible for maintenance and operation of institutional facilities or the Center's operations, project, and systems management functions shall provide the RSO (or SHeD HP/RP representative) with any ionization smoke detectors that have been removed from service and are no longer needed. Alternatively, these units may be processed through Code FE waste management group, whose representatives shall deliver the units to the RSO.

6.13.3 – Documentation associated with the transfer of Smoke Detectors being returned to the vendor or, otherwise, disposed will be maintained as described in the Section on "Transportation of RAM and Wastes."

7.0 RECORDS

(maintained by the RSO, health physicist or HP/RP staff unless otherwise noted)

- Annual occupational radiation worker training (completion and exam results).—Maintained in Agency online training application, SATERN.
- Other training records—Maintained in Agency online training application (SATERN), by SSC supervision, or the RSO.
- Contamination surveys, radiation surveys, and results from radiological analyses

- Sealed source leak tests
- Instrument calibrations (copy)
- GL source inventory
- Licensed source inventory
- Radiation dosimetry reports and other dose records/documentation
- RAM receipts
- Radioactive waste disposals
- U.S. Nuclear Regulatory License 34–00507–16
- Unusual incident reports

8.0 REFERENCES

Document Number	Document Name
10 CFR 1–199	Energy, Chapter 1, Nuclear Regulatory Commission
29 CFR 1910.1096	Department of Labor, Occupational Safety and Health Administration, Part 1910—Occupational Safety and Health Standards, Subpart Z – Toxic and Hazardous Substances, Section 1910.1096 – Ionizing Radiation
49 CFR 171–185	Department of Transportation, Chapter 1, Pipeline and Hazardous Material Safety Administration, Subchapter C—Hazardous Material Regulations, Parts 171-185
GLM–QS–1700.1	NASA Glenn Safety Manual, Chapter 1A, Safety Permit System
GLM–QS–1700.1	NASA Glenn Safety Manual, Chapter 17, Construction Safety
NPR 1800.1	NASA Procedural Requirement, NASA Occupational Health Program Procedures
	International Air Transport Association (IATA), Dangerous Goods Regulations, Section 10—Radioactive Material
Regulatory Guide 8.13	Nuclear Regulatory Commission, Instruction Concerning Prenatal Radiation Exposure
NUREG–1556, Vol. 7	Nuclear Regulatory Commission, Consolidated Guidance About Materials Licenses—Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope
NUREG-1556, Vol. 1	Nuclear Regulatory Commission, Consolidated Guidance About Materials Licenses—Program-Specific Guidance About Portable Gauge Licenses
NUREG–1556, Vol. 16	Nuclear Regulatory Commission, Consolidated Guidance About Materials Licenses—Program-Specific Guidance About Licenses Authorizing Distribution to General Licenses
29 CFR 1926.53	Occupational Safety and Health Administration, “Construction Health and Safety Standards,” Section 1926.53-Ionizing radiation

APPENDIX A.—DEFINITIONS AND ACRONYMS

As low as reasonably achievable (ALARA).—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.

Annual Limit on Intake (ALI).—The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent (CEDE) of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of appendix B to 10 CFR 20)

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 using special nuclear material; (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. Underground ore bodies depleted by these solution extraction operations do not constitute byproduct material within this definition; (3)(i) Any discrete source of radium-226 that is produced, extracted, or converted after extraction for use for a commercial, medical, or research activity; or (ii) Any material that (A) Has been made radioactive by use of a particle accelerator; and (B) Is produced, extracted, or converted after extraction for use in a commercial, medical, or research activity; (4) Any discrete source of naturally occurring radioactive material (NORM), other than source material, that (i) The Commission, in consultation with the Administrator of the Environmental Protection Agency, the Secretary of Energy, the Secretary of Homeland Security, and the head of any other appropriate Federal agency, determines would pose a threat similar to the threat posed by a discrete source of radium-226 to the public health and safety or the common defense and security; and (ii) Is extracted or converted after extraction for use in a commercial, medical, or research activity.

Business Management System (BMS)

Certificates of Competent Authority (CoCA)

Code of Federal Regulations (CFR)

Contamination (radioactive).—The presence of unwanted radioactive material on a surface or within a volume.

Contracting Officer Technical Representative (COTR) or Contracting Officer Representative (COR)

Dangerous goods regulations (DGR)

Decay-in-Storage (DIS)

Department of Transportation (DOT)

Derived Air Concentration (DAC).—The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one Annual Limit on Intake (ALI). DAC values are given in Table 1, Column 3, of appendix B to 10 CFR 20.

Derived Air Concentration-hour (DAC-hour).—The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one Annual Limit on Intake (ALI),

equivalent to a committed effective dose equivalent (CEDE) of 5 rems (0.05 Sv). One DAC-hour is equivalent to a CEDE of 2.5 millirems.

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). 1 Gy = 100 rad.

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. The units of equivalent dose are the rem and the sievert (Sv). 1 Sv = 100 rem.

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 thermoluminescent detectors (TLD), optically-stimulated luminescent (OSL) detectors, self-reading dosimeters (SRD), film badges, or other new technologies as they become accepted by the radiation protection profession.

Environmental Protection Agency (EPA)

Emergency Preparedness Plan (EPP)

Extremity.—For dose purposes, this means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Generally licensed (GL) or General License (GL)

Glenn Research Center (GRC)

Health and Safety Plan (HaSP)

Health Physics (HP)

High radiation area.—An area in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in any 1 hr at 30 cm from the radiation source or from any surface that the radiation penetrates.

Highway route-controlled quantities (HRCQ)

Industrial radiography equipment.—A device using ionizing radiation (from either a sealed nuclear source or an x-ray unit) to examine (via real-time imaging, photographic film, or other imaging media) the macroscopic structures of material by nondestructive methods.

International Air Transport Association (IATA)

International Atomic Energy Agency (IAEA)

Ionizing radiation.—Any radiation (particle or wave) capable of displacing electrons from atoms or molecules, thereby producing ions. Examples include alpha particles, beta particles, gamma rays, 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).

Laboratory Standard Operating Procedure (LSOP)

Lens dose equivalent (LDE).—The external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm (300 mg/cm^2).

Low specific activity (LSA)

NASA Procedural Requirement (NPR)

Naturally occurring or accelerator-produced radioactive material (NARM).—Any radioactive material found in nature or material made radioactive by activation caused by the charged particles of a particle accelerator. It does not include source or special nuclear material. The NARM category of RAM was widely used prior to the NRC redefining the term “byproduct material” in 2007. Before October 1, 2007, byproduct material did not include accelerator-produced radioactive material.

Naturally occurring radioactive material (NORM).—Any radioactive material found in nature. It does not include byproduct, source, or special nuclear material. NORM examples include radium-226 or un-enriched (i.e. natural) uranium.

Nonoccupational radiation workers.—Individuals who handle certain RAM on an infrequent basis (shipping/receiving personnel), or personnel who may need to enter radiologically controlled areas to accomplish tasks that are unrelated to the source of radiation.

Nuclear Regulatory Commission (NRC)

NRC Form 3.—The Nuclear Regulatory Commission's (NRC's) "NOTICE TO EMPLOYEES," which is subtitled "Standards for Protection Against Radiation (Part 20); Notices, Instructions and Reports to Workers; Inspections (Part 19); Employee Protection."

NRC general license.—Authority to possess and use a device containing a radioactive source that 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 broad scope byproduct materials license.—Authority to possess and use a wide variety of byproduct RAM that is issued by the NRC to organizations possessing a large and dynamic inventory of byproduct materials (i.e., universities, certain research and development facilities, hospitals, etc.).

NRC limited scope (i.e., specific) byproduct materials license.—Authority to possess and use specifically identified byproduct RAM that 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 RAM or sources. Use of a generally licensed (GL) device would not classify a user as an occupational radiation worker.

Occupational Safety and Health Administration (OSHA)

Optically Stimulated Luminescent (OSL) detector

Personal Protective Equipment (PPE)

Quality assurance (QA)

Radiation area.—An area in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in any 1 hr at 30 cm from the radiation source or from any surface that the radiation penetrates.

Radiation-generating equipment (RGE).—A machine or system that can generate or emit ionizing radiation during operation, except those that emit ionizing radiation only from radioactive material.

Radiation Protection (RP)

Radiation Safety Officer (RSO)

Radioactive material or Radioactive materials (RAM).—Materials that exhibit the property of radioactivity.

Radioactive materials area.—Any area where licensed RAM 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.

Radiographic testing (RT).—Another phrase for industrial radiography.

Reference man.—A theoretical individual with "normal" attributes or characteristics which was developed by the International Commission on Radiological Protection in 1974 to be used when modeling radiological impact on humans.

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.

Safety and Health(SHeD)

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

Self-reading dosimeters (SRD)

Shallow-dose equivalent (SDE).—The external exposure of the skin of the whole body or the skin of an extremity, is taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm^2).

Sievert (Sv).—The International System (SI) unit used for dose equivalent. The dose equivalent in Sievert is equal to the absorbed dose in Gray multiplied by the quality factor. Also, 1 Sievert = 100 rem.

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, 1/20 of 1 percent (0.05%), or more, of uranium, thorium, or any combination of uranium and thorium. Note: source material does not include 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 SNM, but does not include source material or (2) Any material artificially enriched by any of the foregoing but does not include source material.

Support service contractor (SSC)

Surface-contaminated object (SCO)

Temporary job site.—Any location (i.e., in the field) where industrial radiography is performed other than permanent radiographic installations specifically designed for such activities.

Thermoluminescent detectors (TLD)

Total effective dose equivalent (TEDE).—The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). This dose is commonly referred to as the “whole body dose.”

Transportation index (TI)

Type A quantity.—A quantity of radioactive material allowed to be shipped in a Type A shipping container. Such quantities are a function of the form of the material, the presence and robustness of any encapsulations, as well as the radiological characteristics of the radioisotope, which all factor into the extent of radiological hazard possible during a transportation accident/incident.

APPENDIX B.—RADIATION SAFETY OFFICER RESPONSIBILITIES

The Radiation Safety Officer (RSO) is appointed by the Director to implement the radiation protection programs at the NASA Glenn Research Center (GRC). The RSO's responsibilities shall include the items listed below. In instances where the RSO delegates the authority to perform identified activities to other individuals, the RSO shall remain responsible for said performance.

1. Administer and coordinate the radiation protection programs for all activities involving radioactive material (RAM) and ionizing radiation-generating equipment (RGE) 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; and maintain exposure records
    b. Coordinate the radioactive waste disposal program; provide, collect, store, and dispose of waste containers; monitor effluent; maintain filter systems; and maintain waste disposal records
    c. Supervise the performance of sealed source leak test and maintain inventories
4. Control all licensed radionuclides at GRC as follows:
    a. Review and approve all requests for procurement of RAM
    b. Assure that sources are properly represented on the Center's materials license
    c. Maintain an inventory of RAM at GRC and conduct physical inventories at least semi-annually to comply with license requirements
    d. Upon notification of receipt of RAM shipment, coordinate package survey(s) and open package in approved area and maintain material receipt records
    e. Authorize all transfers of RAM between Center locations
    f. Approve containers and locations for storage of all RAM
    g. Package or inspect packaging for all offsite transfers of RAM, survey packages, assure compliance with NRC and Department of Transportation regulations, and maintain shipment records
5. Conduct or coordinate training programs in radiation safety
6. Unless otherwise specificed, maintain all records related to the radiation protection programs
7. Terminate any activity involving RAM or ionizing radiation that is found to be a threat to health, property, or the environment

APPENDIX C.—PROCEDURES FOR PERSONAL DOSIMETRY

Note: Elements of these procedures may be implemented or otherwise carried out by contractor staff supporting GRC's radiation protection programs.

Obtaining Dosimetry

Individuals needing radiation dosimetry shall contact the Radiation Safety Officer (RSO) or designee. After satisfying training requirements and providing needed personal information, the individual will be issued their dosimetry and instructed on its use. New occupational radiation workers shall also be required to provide the RSO or their designee 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 appropriate management of their dose received in their inception year and over their career at the NASA Glenn Research Center (GRC).

Temporary Need for Dosimetry

Temporary monitoring devices can be issued to transient personnel who may be assigned short-term work in a radiologically-impacted area. The RSO shall evaluate the work 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 (externally) to the head, trunk, and thigh area of a worker. This dose is known as the deep dose equivalent (DDE). The referenced region of the body includes the major organs and blood-forming areas that would be more susceptible to chronic radiation exposure effects. These badges also provide an estimate of the wearer's skin dose and the dose to their eye lens, which are termed the shallow dose equivalent (SDE) and lens dose equivalent (LDE), respectively. The whole body badge shall be worn in its holder on the front of an individual's body between their head and waist, or as directed by the RSO.

Self-Reading

Self-reading dosimeters (SRDs) are used to provide a real-time estimate of an individual's dose to x-rays or gamma rays. SRDs 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 shall be worn similarly to the whole body badge. SRDs 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 typically become the individual's official dose of record.

Ring and Extremity Badges

Ring and extremity 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 shall immediately notify the RSO. Users would need to provide a written account detailing the event, who 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 were 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 were proceeding 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 individual's dose(s).

Additional Requirements for Dosimetry Users - Dosimetry Users shall:

- 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.
- 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.
- Do not wear your dosimeter during a medical x-ray or computed tomography scan.
- Consult with the RSO regarding any concerns or questions on the use of dosimetry or the dosimetry program.

Dosimetry Records

Dosimetry reports are on file with the RSO. As required by 10 CFR 19.13; program participants shall receive an annual record of their dose and shall be advised to keep such records for their personal use.

APPENDIX D.—CONTAMINATION CONTROL GUIDELINES

Note: The information below shall be considered basic guidance. Task-specific contamination control procedures, protocols, or work instructions will be developed and implemented for activities involving the use or handling of radioactive materials (RAM).

Personnel Contamination and Personal Protective Equipment (PPE)

1. At a minimum, individuals shall wear impermeable gloves (i.e., latex, nitrile, etc.) while working with RAM. Other glove types may be specified depending upon other materials or chemicals being handled. Also, additional clothing may be specified to cover other body parts. Gloves/clothing are to be removed when work is completed. Gloves/clothing that are suspected of being contaminated should be isolated, and the Radiation Safety Officer (RSO) should be contacted.
2. The user shall immediately contact the RSO or their designee if personnel contamination is suspected.
3. Open wounds shall be dressed and covered by impermeable PPE when working with RAM of any form.

Personnel Decontamination

In general, any contamination of body surfaces shall be addressed by decontamination methods prescribed in the GRC health physics procedures. Such activities should be performed by or under the supervision of the RSO or a Safety and Health Division (SHeD) HP/RP representative. Decontaminating agents and methods may become increasingly abrasive depending on the type and level of contamination present.

In general, once any contaminated clothing is removed, personnel decontamination is an iterative process involve steps where contamination is removed followed by re-monitoring the impacted area. Steps are repeated as needed and decontamination techniques progress as necessary to clear the impacted area. Dry techniques are typically attempted before wet methods. All decontamination materials should be collected for appropriate disposal.

Area Contamination

1. Removable contamination shall not be tolerated on exposed surfaces, such as bench tops and floors and shall be removed as soon as possible, or the area shall be isolated.
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 RAM 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

In accordance with the program's policy for ALARA exposures, contamination found in unrestricted areas shall be immediately decontaminated to background levels, if practical. When such levels are not reasonably feasible, the surface contamination levels observed should at least be less than the limits specified in the table below. The release limits in this table apply to all surfaces, including structures (walls, floors, doors, etc.), furnishings (bench tops, file cabinets, sinks, etc.) and articles (equipment, tools, etc.) and are based upon guidance from Regulatory Guide 1.86. The process of assessing potential surface contamination for an area or an item will involve using as much available information about the subject surface, conservative assumptions, as needed, and some pragmatic decision-making. As needed, the RSO may, on a case-by-case basis, authorize alternate contamination assessment plans based upon case-specific information or data.

TABLE D.1.—MAXIMUM PERMISSIBLE CONTAMINATION LEVELS FOR UNRESTRICTED USE

NUCLIDE[a]	TOTAL		REMOVABLE[b e] (dpm/100 cm^2)
	AVERAGE[b c] (dpm/100 cm^2)	MAXIMUM[b d] (dpm/100 cm^2)	
U-natural, U-235, U-238, and associated decay products	5,000 α (alpha)	15,000 α	1,000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm β-γ (beta-gamma)	15,000 dpm β-γ	1,000 dpm β-γ

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should be applied independently.
[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector by background, efficiency, and geometric factors associated with the instrumentation.
[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such objects.
[d] The maximum contamination level applies to an area of not more than 100 cm2.
[e] The amount of removable radioactive material per 100 cm2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of know efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Airborne Contamination and Controls

Containing, or, controlling RAM that could get dispersed in the air is the best way to limit or prevent airborne contamination. Personnel use of respirators may be required if prescribed controls do not limit airborne contamination to appropriate levels as demonstrated by air sampling.

Typical methods used to control or limit the possibility of airborne contamination include:

1. Work within a controlled environment (i.e. glove box, or glove bag)
2. Work within a properly functioning laboratory fume hood designated for radiological activities.
3. Cover or encapsulate surfaces that could be the source of airborne contaminants.
4. Direct water, or other liquid, as a mist or spray to wet down the zone where airborne contaminants may be generated.
5. Use properly filtered local exhaust ventilation (LEV) to remove potential air contaminant at or near their point of generation.

If the airborne environment within a room was determined to be contaminated, methods to decontaminate would include containing/isolating the room, decontaminating the air volume with a properly filter LEV system, and then cleaning up any surface contamination.

APPENDIX E.—SUMMARY OF RADIOLOGICAL SURVEY REQUIREMENTS

Source Leakage Tests

Sealed sources and plated foil sources shall be leak tested in accordance with Nuclear Regulatory Commission (NRC) license conditions or applicable sealed-source device registry (SSDR) criteria. Generally licensed (GL) devices shall be leak tested in accordance with the NRC's or the manufacturer's stated wipe test criterion. Unless otherwise stated in SSDR documentation, the periodicity of the leakage tests for sources meeting established criteria shall be every 3 months for any alpha-emitting sources and every 6 months for all others. 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 shall specify the monitoring method to be used.

Area Radiation Surveys

Radiation surveys shall be conducted in areas where radioactive material (RAM) is 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 shall be conducted in areas identified by the Radiation Safety Officer (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. Guidance on the periodicity for such surveys is provided in Appendix Q of NUREG 1556 Volume 7.

Airborne Radioactivity Surveys

Depending upon the work activity, RAM characteristics, and type of engineering controls, area or personnel air monitoring may be required to survey possible airborne contamination. The RSO shall prescribe when such surveys are to be conducted.

Radiography Radiation Surveys

Contractor radiographers shall perform monitoring during radiography activities to comply with their license and other regulatory requirements. The RSO or Safety and Health Division (SHeD) health physics representative may observe such activities, if performed during normal working hours, to verify the adequacy of established boundaries.

APPENDIX F.—MATERIAL RECEIPT AND ACCOUNTABILITY

Receiving Radioactive Material (RAM) Packages

The following procedures apply to the NASA Glenn Research Center (GRC) receiving department staff at Lewis Field or Plum Brook Station who will be processing the receipt of packages known to contain RAM. These include "Labeled" packages with Department of Transportation (DOT) shipping labels for RAM (i.e., White 1, Yellow II, or Yellow III labels with characteristic radiation trefoil image) and "Excepted" packages with UN ID number markings. While not anticipated, if the Center expected to receive a package containing quantities of radioactive material (RAM) in excess of a "Type A" quantity, then the RSO would coordinate this receipt activity with GRC receiving department personnel as needed to satisfy NRC rules for receipt in 10 CFR 20.1906.

> ***Note:*** *Labeled RAM packages delivered to Lewis Field shall be "received" at Building 215. Other, non-labeled RAM packages delivered to Lewis Field can be received at either Building 152 or 215. Plum Brook Station will receive all packages at Building 9209.*
>
> ***Note:*** *A posting in the receiving department areas identifies examples of radioactive labels to look for on the packages, an explanation of what the labels mean, and instructions for handling RAM packages.*
>
> ***Note:*** *GRC does not have an afterhours shipping and receiving process.*

During normal working hours, immediately upon receipt of any package known to contain RAM, receiving department personnel shall visually inspect each package for any signs of shipping damage such as crushed or punctured containers or signs of dampness. Any obvious damage shall be reported to the RSO or other designated Safety and Health Division (SHeD) employee **immediately**. (If needed, the Emergency Dispatcher can be called and asked to make contact with the RSO or SHeD Staff.) Workers shall be kept away from the location of the damaged package and the parcel shall not be moved or touched. In addition, the person delivering the damaged package shall be asked to remain at the dock area until that individual and their vehicle can be appropriately monitored. Efforts shall be made to limit the potential spread of contamination from the suspected leaking package.

Receiving department personnel shall notify the RSO or other designated SHeD employee upon the receipt of a package containing RAM or radioactive sources. SHeD health physics / radiation protection (HP/RP) staff are required to monitor the package as soon as practical after receipt, but not later than 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. Receiving department personnel shall **first** notify a SHeD HP/RP contact, regardless of to whom the package is addressed. The SHeD HP/RP representative will pick up the package and notify the addressee after all license and regulatory requirements have been met.

Monitoring and Picking Up RAM Packages for Delivery to Building 49

SHeD HP/RP personnel will report to the Receiving Department location with a radiation survey meter and wipe test supplies. Procedures for handling RAM packages prior to delivery to Building 49 shall be as follows:

> ***Note:*** *Record all survey measurements and information in accordance with GRC health physics procedures.*

- Wear gloves (latex, nitrile, etc.) when handling packages to prevent potential hand contamination.
- Visually inspect the package for any sign of damage (e.g., crushed, punctured, and dampness). If damage is noted, stop and notify the RSO.
- For "Labeled" packages, 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 m 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.
- For "Excepted" packages, measure the dose rate on contact with the package surface. This dose rate should not exceed 0.5 mrem/hr. If it is higher than expected, stop and notify the RSO.

STOP POINTS: >10 mrem/hr at 1 m, or >200 mrem/hr on contact; call RSO immediately and do not open package.

Note: *The final delivery carrier and Nuclear Regulatory Commission (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 71.47.*

- Wipe at least 300 cm^2 of the exterior surface of the package and analyze the wipe.

  STOP POINTS: >22 dpm/cm^2 alpha or >220 dpm/cm^2 beta-gamma; call RSO immediately and do not open package.

  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).*

- Using good lifting techniques and requesting help as needed, deliver package to building 49.

Opening RAM Packages

SHeD health physics/radiation protection personnel are responsible for opening RAM packages. Unless otherwise directed by the RSO, such packages will be opened in room 3 or 4 of building 49 or in the designated radioactive source/RAM storage area. Procedures for opening RAM packages shall be as follows:

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

- Wear gloves (latex, nitrile, etc.) when handling packages to prevent potential hand contamination.
- 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.
- For sealed radioactive sources, or, devices containing such sources, perform a source leakage test. As appropriate, follow manufacture's guidance on performing such contamination surveys.

APPENDIX G.—EMERGENCY PROCEDURES

Incident Involving Radioactive Releases or Spills

All emergencies in areas where RAM are being used shall be reported by dialing 911 to contact GRC Emergency Dispatch at either Lewis Field or Plum Brook Station's Dispatch. If using a cell phone, individuals making such a report should call (216) 433-8888 when at Lewis Field or (419) 621-3222 when at Plum Brook Station. The dispatcher shall immediately initiate contact with the Radiation Safety Officer (RSO) or other Safety and Health Division (SHeD) personnel identified in ANNEX L of the Center's Emergency Preparedness Plan (EPP) when at Lewis Field and the Emergency Action Procedures when at Plum Brook Station.

Procedures for the Radiation Worker

- 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 particles.
- Lock the room or barricade the area.
- Notify the RSO or SHeD health physics/radiation protection staff.

Procedures for the SHeD Health Physics/Radiation Protection Staff

- Stop the release of RAM 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 shall be determined by the RSO or HP/RP representative.)
- Contaminated clothing shall be removed as soon as possible and placed in a plastic bag.
- Skin shall be flushed with lukewarm water and then washed with soap and water (see Appendix D).

Incident Involving a Stuck Radiography Source

The Construction Contractor Radiographer shall initiate their written emergency procedures and any other actions identified in their Health and Safety Plan (HaSP). This shall involve contacting the Lewis Field or Plum Brook Station Dispatcher, who, in turn shall immediately contact the RSO or other SHeD personnel identified in ANNEX L of the center's EPP for Lewis Field and the Emergency Action Procedures for Plum Brook Station. 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.

Incident Involving an Injured Radiography Contractor and a Non-housed Source

The Construction Contractor Radiographer shall initiate their written emergency procedures and any other actions identified in their HaSP. This shall involve contacting the Lewis Field or Plum Brook Station Dispatcher, who, in turn shall immediately contact the RSO or other SHeD personnel identified in ANNEX L of the Center's EPP for Lewis Field and the Emergency Action Procedures for Plum Brook Station. Since two licensed personnel are required when performing radiography, at least one should be available to initiate this sequence of events and house the source within its shielding, even if their partner is incapacitated. If housing the source was not possible or was delayed, treatment of acute injury or illness shall not be delayed because of radiation levels anticipated in such a situation.

Incident Involving Nuclear Gauge Damaged by Heavy Equipment

The construction contractor or NASA employee using the nuclear moisture/density gauge shall initiate their written emergency procedures and any other actions identified in their HaSP or safety permit. This shall involve contacting the Lewis Field or Plum Brook Station Dispatcher, who, in turn shall immediately contact the RSO or other SHeD personnel identified in ANNEX L of the Center's EPP for Lewis Field and the Emergency Action Procedures for Plum Brook Station. In general, the workers shall follow the spill response actions described above, keeping the area isolated and minimizing the spread of potential contamination by securing the heavy equipment that crushed the gauge.

APPENDIX H.—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 radioactive material (RAM) shipments likely to be made by the NASA Glenn Research Center (GRC). The Nuclear Regulatory Commission's (NRC) 10 Code of Federal Regulations (CFR) 71.5(b) states that if DOT regulations are not applicable to a shipment of licensed RAM, the licensee is required to comply with the NRC regulation, 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 DOT standards and requirements in 49 CFR Parts 170 to 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

> *Note: The definition and understanding of the terms "Special Form" or "Normal Form" (173.403 and 173.469) are crucial to classifying packages. 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 encapsulation, which typically is issued by a country's Competent Authority for the purposes of the Regulations of the International Atomic Energy Agency (IAEA). In the United States, such Certificates of Competent Authority (CoCA) are issued by the DOT and in Great Britain, these CoCAs are issued by the Secretary of State for Transportation. Copies of this certification should be submitted with the shipping paperwork and maintained in the RSO's files for transferred sources.*

- 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 an instrument or 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).
- Type A Quantity.—The A_1 and A_2 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 RAM that exceeds the A_1 and A_2 quantities found within 173.435 for special form and normal form sources, respectively.
- Highway Route Controlled Quantity.—Quantity of RAM that exceeds 3000 times the A_1 and A_2 quantities found within 173.435 for special form and normal form sources, respectively.
- Low specific activity (LSA) and surface-contaminated objects (SCOs).—Specials categories of shipments that allow for relaxation of DOT rules based upon the reduced hazard associated with shipment.

The RSO shall 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 shall be limited to 200 mrem/hr and 10 mrem/hr, respectively. If these levels are exceeded, then that package shall be shipped "Exclusive Use" and shall not be transported by aircraft. "Exclusive Use" shipments are subject to 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 mrem/hr (rounded to the nearest tenth) measured at 1 meter from the package surface. If the dose rate is less than 0.05 mrem/hr, then the TI is defined to be 0.

Levels of nonfixed (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 shall be taken over an area of at least 300 cm^2. The allowable limits are 22 dpm/cm^2 for beta and gamma emitters (and low toxicity alpha emitters), and 2.2 dpm/cm^2 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, and 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 shall be marked with the proper shipping name and identification number (e.g., "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 an "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 shall 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 1 m 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 also 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 percent 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 TI.

There are three primary labels used on RAM 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	Transportation index
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

Note that it is 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, and 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))
- 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 shall 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 shall be immediately available to vehicle operators, pilots, etc., or facility personnel, and is required to be on-hand as long as the RAM 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 shall also provide a 24-hour emergency response telephone number for use in the event of an emergency involving the hazardous material. This number shall be monitored as long as the RAM is in transit and shall connect the caller with a person who has specific knowledge of the RAM in shipment, or with access to someone with specific knowledge.

The information shall be printed legibly in English and be available for use away from the RAM package. The information could be presented (1) on a shipping document, (2) on another document providing the required information (e.g., "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 shall be utilized on the following shipments of RAM:

- Yellow III shipments
- Yellow III exclusive use shipments
- LSA and SCO exclusive use shipments
- Highway route-controlled quantity shipments (black-bordered placard)

Placards shall be placed on the front, back, and two sides of the vehicle.

Special Classifications

Certain RAM 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 specific 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 RAM packaging (173.428). Specific requirements for each category are provided in the referenced regulations.

The shipment of LSA and SCOs 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.

APPENDIX I.—GUIDANCE FOR CONSTRUCTION CONTRACTOR USE OF RADIOACTIVE SOURCES

Note: *The Radiation Safety Officer's (RSO's) approval on a Health and Safety Plan (HaSP) covers the radiation safety elements of the task; other industrial safety and environmental concerns should be covered within the HaSP (e.g., scaffolding, working aloft, and disposal of chemicals). Because the radiographic testing (RT) or portable gauge contractor is often a subcontractor of a subcontractor, it would probably be appropriate to get them to sign off on the prime contractor's HaSP or get them to issue a letter (with company letterhead) indicating they will abide by the prime contractor's HaSP.*

Note: *If the RT elements of a job were not addressed in the original HaSP, an addendum to this HaSP or a radiation safety plan could be submitted by or on behalf of the RT contractor. For the purposes of this document, the use of "HaSP" may also refer to a radiation safety plan or HaSP addendum.*

Industrial Radiography

Note: *Consideration of the specific area where the radiography is to be performed shall be demonstrated within the proposed plan. Preferably, this familiarity is garnered by the RT company representative working with the hiring contractor, Facilities Division representative, RSO and, possibly, the building or facility manager.*

- The NASA organization responsible for bringing in the radiographer shall have a representative onsite for oversight of and coordination with the industrial radiography contractor. Appendix J is provided as an informational guidance document for this on-site NASA (civil servant or support service contractor) representative.
- A copy of the construction contractor's radioactive materials (RAM) license shall be included with the Health and Safety Plan (HaSP) or otherwise provided to the RSO.

  Note: *As a Federal facility, GRC falls under the jurisdiction of the NRC. Radiography companies shall possess an NRC license or NRC reciprocity for their state license.*

- The HaSP for the radiography activity shall demonstrate specific knowledge about the planned shots, how they will be conducted safely, and what coordination issues might exist (i.e., impact on NASA Glenn Research Center (GRC) employees or other construction contractors working in the nearby vicinity). Some considerations include location and orientation of the planned shots, building and room layout, building construction materials, building occupancy, and employee work schedules.
- The HaSP should include a diagram or map showing the location of the 2 mrem/hr isodose line. Assumptions used in establishing this boundary should be identified in the HaSP or its attachments. Alternatively, a written description of the exclusion area is permissible. Recognizing that the 2 mrem/hr isodose line is a conservative boundary, the RSO will consider alternate exclusion zone planning based upon anticipated x-ray shot frequency.
- Areas that need to be evacuated during the radiography shots along with how such areas are to be secured shall be identified in the HaSP. Coordination with other workers may involve working with the appropriate building manager, facility manager, or the construction/project manager. Industrial radiography is commonly performed on off-shifts or over the weekend.
- Any other necessary special controls to be implemented during radiography activities shall be described in the HaSP.
- The HaSP shall list emergency contact numbers for the contractor's RSO and the GRC RSO (dispatch).
- The radiographer shall comply with all conditions of their radiography license. Required records (training, procedures, license, etc.) shall be made available to GRC personnel when the contractor is onsite. The RSO can also ask for such documentation during the HaSP review and approval process.

Portable Gauge Use

- A copy of the construction contractor's RAM license shall be included with the HaSP or otherwise provided to the RSO.

Note: *As a Federal facility, GRC falls under the jurisdiction of the NRC. Radiography companies shall have an NRC license or NRC reciprocity for their state license.*

- The HaSP shall include the current training record(s) for the proposed operator(s).
- The HaSP shall include the current source leak test results for the instruments to be used.
- The HaSP shall 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 GRC RSO (dispatch)
- In addition, emergency and operating instructions shall be kept with the gauge at all times.
- If the gauge is damaged, stolen, or lost the contractor shall contact the GRC RSO 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 the gauge 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

APPENDIX J.—INFORMATIONAL BRIEFING SHEET FOR OVERSIGHT OF RADIOGRAPHIC TESTING

Informational Briefing Sheet for Oversight of Radiographic Testing (rev. 02/14)

Radiographic Testing (RT), or Industrial Radiography, is a non-destructive test method typically used for the macroscopic examination of metal structures or welds. High-energy photons (either gamma-rays or x-rays) are used to examine a target zone with the resulting image being imparted onto either photographic film or a digital image capturing device. Regardless of the photon type (either gamma-rays or x-rays), the action is herein described as an "exposure event" or "exposure shot." In most instances, the industrial radiography will involve the use of gamma rays from a radioactive source such as Iridium-192 or Cobalt-60 (denoted here as "GAMMA"). Lower energy photons from x-ray tubes may be needed when performing industrial radiography on light metals and other less-dense materials. (denoted as "X-RAY")

The NASA organization (civil service or support-service contractor) responsible for bringing in the radiographer shall have a representative onsite for oversight of and coordination with the RT contractor. As the NASA entity coordinating this activity, there are certain basic requirements that you shall to be aware of: (if neither GAMMA nor X-RAY are denoted, then the requirement applies to BOTH.)

- Security shall be notified in advance of the arrival of the RT contractor.
- The RT contractor shall have an approved Radiation Safety Plan or a Health and Safety Plan (HaSP) that covers the scope of the proposed work. (e.g., addendum for the radiography)
- At least two (2) individuals from the RT contractor shall be present; one of these persons is the "radiographer" while the other is the "radiographer's assistant."
- In addition to following specific regulations concerning the radiation aspect of the job, the RT contactors shall obey all pertinent industrial safety (i.e., OSHA) requirements, such as those for personal protective equipment, ladder safety, scaffolding, working aloft, confined space, etc. These elements of work safety are to be addressed in the HaSP.
- The "camera," which contains the radioactive source, shall be under the direct surveillance of the radiographer or their assistant once it has been removed from their truck (GAMMA). Similarly, the x-ray tube/controller, when unlocked, must be under direct surveillance. (X-RAY)
- The RT contactors shall use a <u>whole body dosimeter</u> (e.g., TLD or film badge) AND a <u>direct-reading dosimeter</u> (GAMMA and X-RAY). For radioactive source-based radiography, each RT contractor must ALSO use an <u>alarming doserate meter</u> (GAMMA).
- The RT contractor shall establish the exclusion zone prior to the exposure events. This includes setting up barricades, posting warning signs and verifying that the area is clear of other people. ONLY the RT contractors are permitted within the exclusion zone during exposure shots.
- While performing exposure shots, BOTH of the RT contractors shall be present with one controlling the camera/x-ray tube and the other watching to ensure the exclusion area is not violated.
- After each exposure event, the RT contractor shall use a <u>radiation survey meter</u> to verify that the source is properly housed in the shielded "camera" (GAMMA) or that the x-ray tube is de-energized (X-RAY)
- The RT contractor's truck contains a film development laboratory if photographic film is used. Fluids or chemicals shall not be dumped onto GRC property.

If you observe the Industrial Radiographer contractor violate these requirements or if you have concerns about how they are performing their work, you are to confront them with your concerns. If you continue to have such concerns, contact security dispatch at 216.433.2088 and ask to have the Glenn Radiation Safety Officer (RSO) contacted. You may also contact the RT contractor's RSO or emergency contact, whose contact information should be in the HaSP or written safety plan for the job.

APPENDIX K.—GUIDANCE FOR RADIOACTIVE WASTE MANAGEMENT PROCEDURES

Specific Procedures

- Site- or task-specific procedures for RAM use and handling shall describe waste collection and handling process for the subject activity. HP/RP staff will periodically collect such materials for consolidation and processing in accordance with GRC health physics procedures.

General Guidelines

- All radioactivity labels shall be defaced or removed from containers and packages prior to disposal in ordinary (nonradioactive) waste. If waste is compacted, all labels that are visible in the compacted mass shall be defaced or removed.
- Remind workers that nonradioactive waste such as leftover reagents, boxes, and packaging material shall not be mixed with radioactive waste.
- Occasionally monitor procedures to ensure that radioactive waste is not created unnecessarily. Review new procedures to ensure that waste is handled in a manner consistent with established procedures.
- Waste management program shall include waste handling procedures for the users within their laboratories or assigned areas, and, as needed, for waste handlers who may collect waste from areas of use to bring to the storage area for eventual disposal.
- As needed, housekeeping staff shall be provided adequate training to avoid the possibility of unauthorized disposal or exposure of these individuals to radioactive material (RAM) 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) shall be disposed of by DIS.
- Short-lived waste shall be segregated from long-lived waste (half-life greater than 120 days) at the source.
- Waste shall be stored in suitable well-marked containers, and the containers should provide adequate shielding.
- Liquid and solid wastes shall be stored separately.
- When the container is full, it shall be sealed. The sealed container shall be identified with a label affixed or attached to it.
- The identification label shall include the date when the container was sealed, the longest-lived radioisotope in the container, date when 10 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 shall 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 shall 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.

Procedure for Disposal of Liquids into Sanitary Sewerage

> ***Note:*** *Currently there are no such activities at the NASA Glenn Research Center involving RAM-containing effluents directed to sanitary sewers. In addition, the Center's Nuclear Regulatory Commission (NRC) RAM license does not currently allow for possession of the type of RAM that would qualify for release into the sanitary sewer system per 10 CFR 20.2003. Additionally, prior to initiating such a practice, Center personnel shall coordinate this activity with the Northeast Ohio Regional Sewer District.*

Notifications

- The Radiation Safety Officer (RSO) shall complete periodic notification forms for the Northeast Ohio Regional Sewer District that document the Center's release of RAM into the sanitary sewer system.

APPENDIX L.—SELF-LUMINOUS EXIT SIGN PROCEDURES

Acquisition

Tritium-containing exit signs are acquired by the Center primarily by two basic mechanisms.

First, such signs may have been specified for installation by a facility construction or renovation project and, as such, would be installed during that project. The prime construction contractor for this project shall turn over all information regarding the signs to their contact within the operations, project, or systems management function of the Center's Facility Division.

> ***Note:*** *When purchased, the distributor/seller of tritium-containing exit signs are required to provide the following information to the "purchaser" (a.k.a. "general licensee") prior to transfer of the signs themselves:*
>
> *(1) a copy of the applicable portions of the general license found in 10 CFR 31.5;*
>
> *(2) copies of 10 CFR 31.2, 30.51, 20.2201, and 20.2202*
>
> *(3) a list of services that may only be performed by a specific licensee, which would be the manufacturer or servicer of the signs*
>
> *(4) information on acceptable disposal options for the device and the estimated cost for disposal*
>
> *(5) an indication that NRC's policy is to issue high civil enforcement penalties for improper disposal of devices*

This information is forwarded to the support service contractor (SSC) responsible for the maintenance and operation of institutional facilities. Following installation, this same SCC takes responsibility for the signs (and other life safety equipment) following a thorough review and inspection of the newly constructed or renovated area. The SSC shall document all available information for the signs (manufacturer, model, serial number, manufacture date, and effective useful life) as they barcode and add these units to their sign inventory. Gathering this data may require temporarily uninstalling and then reinstalling the signs depending upon how they are installed and the amount of information provided by the construction or renovation contractor.

Second, the signs may have been procured directly by the SSC responsible for maintenance and operation of institutional facilities to satisfy a NASA request or to meet NASA requirements. Again, the SSC shall capture the relevant information from the sign for updating the tritium exit sign inventory.

Inventory and Physical Inventorying

The support service contractor responsible for the maintenance and operation of institutional facilities shall maintain an electronic inventory of the tritium-containing exit signs. At a minimum, this list shall include the information specified below:

> ***Note:*** *For "new" additions to the inventory, all of the information below should be captured. For "legacy signs" (i.e., those in place before the adoption of this procedure), the SSC should include as much information as possible in the inventory record for the unit and, when opportunities arise, gather the remaining data for updating the entry.*

- Local barcode or identifiable number (if applicable)
- Manufacturer name, model, and unit serial number
- Manufacture date and effective lifespan
- Relevant location information

The SSC responsible for the maintenance and operation of institutional facilities shall, at least annually, physically inventory and inspect each sign, including those in storage cabinets. This physical inventory shall assure that the listed sign, as referenced by its serial number or local barcode number, is located in the listed location. The purpose of the inspection is to ensure that all letter segments are functional (i.e., adequately luminescent) so as to meet applicable life safety visibility criteria and confirm that the radioactive tritium gas containers are intact. The

contracting office technical representative (COTR) for the SSC shall provide a copy of this inventory to the Radiation Safety Officer (RSO) at least annually and whenever so requested.

Handling, Installation, and Removal

While the signs are considered inherently safe enough to be handled or used by anyone with no radiation training or experience, there are certainly conditions associated with their use as one can see by reviewing the requirements for general licensees. The two predominant themes in these requirements are (1) use the units only as built and as intended (e.g., do not modify, deface, or disassemble signs) and (2) possess the units responsibly (e.g., maintain accountability of and properly dispose of signs).

Signs shall be installed per manufacturers' guidance or using sound carpentry practices. When removing signs from the wall or from their ceiling mounts, one should take care not to drop the units and ensure that they are properly stored. While dropping one of these signs could damage the sign's case or facing, it is unlikely that the shock would damage the tritium containers, although it is possible. One would know that a tritium container had failed if a letter segment was no longer luminescent or if they visibly saw the broken capsule. A more likely scenario would be improper handling resulting in a sign being crushed by construction activities.

When taken out of service, tritium exit signs shall either be turned over to the RSO if they are to be returned to the vendor for disposal, or they are to be placed in secure storage awaiting reinstallation or reuse. In all cases, the inventory record shall be appropriately updated.

Response to Broken Tritium Sign with Release of H–3

If a sign was dropped, crushed, or otherwise damaged to the point such that an individual suspects there was a possible release of tritium (e.g., sign shows significant damage or not all sign segments appear to be functional), the person shall:

- Leave area and keep others from entering.
- Contact the emergency dispatcher (base phone - dial 911, mobile phone – dial (216) 433-8888 at Lewis Field or (419) 621-3222) at Plum Brook Station) and ask to have the RSO or HP/PR representative contacted.
- If possible, attempt to increase ventilation to the affected area.
- Identify individuals who were possibly exposed to the released tritium. With the assistance of HP/RP staff, these individuals should thoroughly wash their exposed areas of skin (hands, arms, and face) with soap and warm water in such a fashion to contain and collect the water and other materials used so it can be evaluated for proper disposal.

The RSO or SHeD HP/RP representative shall:

- Verify whether or not the luminescent sign segments are intact.
- If no segments are broken, then the sign can be put into storage awaiting disposal or back into service (as appropriate).
- If all segments are not intact, then proceed with cleaning up and packaging the sign.
- The protective clothing required for cleanup usually consists of rubber/latex/nitrile gloves and, possibly booties. The broken sign and any miscellaneous pieces should be double bagged and sealed in plastic. If available, a small amount of silica gel desiccant should be added inside the inner bag. Materials used during cleanup, including water, will be segregated and evaluated for proper disposal.
- The RSO will brief the individuals involved in the incident to discuss any exposure concerns.
- The RSO will investigate the cause of the event and work with the entities involved to try and improve any causative activities or factors.

- The RSO will coordinate with the manufacturer and the Center's RAM shipper the shipment of the broken sign back to the manufacturer.
- The RSO will make any necessary reports to the Nuclear Regulatory Commission.