UTAH STATE UNIVERSITY

RADIATION SAFETY HANDBOOK

June 2016

APPENDICES

G - Definitions and References

NOTES

Fundamentals of radiation and radiation safety are available in USU's Radiation Safety Awareness Guide, as well as from credible Web (Internet) and printed resources.

Radiation Safety Program forms are available through USU's Radiation Safety Officer.

Appendices to this handbook address daily operations.

Italicized portions, unless otherwise indicated, are excerpts from USU's current radioactive material license (lic.) and license application (app.). References for other excerpts are in brackets { }.

INTRODUCTION

The State of Utah's Division of Waste Management and Radiation Control (DWMRC) licenses Utah State University (USU) to use radioactive material and devices for research projects. For several decades USU's license has permitted research using dispensable radio-isotopes and sealed radioactive sources. In exchange for permission USU has systems and mechanisms to effectively limit exposure and control access to licensed radioactive material.

USU's Radiation Safety Committee (Committee) has, since its charter in 1958, provided safety information for researchers using ionizing radiation. The first handbook was adopted in 1975, and subsequent revisions incorporated updates to regulations, official guidance, and USU's license.

RADIATION SAFETY PROGRAM ADMINISTRATION

Utah State University (USU) provides strong managerial oversight and control of the Radiation Safety Program (Program). The Program is part of campus Environmental Health & Safety (EH&S), which is part of the Office of Research and Graduate Studies. Direct oversight of the Program is provided by the Radiation Safety Committee (Committee) and EH&S. (app. 7-1)

Radiation Safety Committee (RSC).

Specific responsibilities of the Committee were established in a letter, dated December 23, 1958, from the Vice President for Research to the President of USU. Those responsibilities [include]:

1. Assume responsibility, from the standpoint of radiological safety, for all USU programs involving radioactivity or radiation producing devices.
2. Review, approve, or disapprove permission for the use of radioactivity

or radiation producing devices.
3. If necessary, prescribe special conditions and requirements to assure safety.
4. Committee approval must be received before any project is initiated or before any substantial change is made in an original protocol. (app. 7-2)

Committee Chair (Chair).

The Committee Chair serves as administrative officer in promulgating rules, policies, and actions established by the Committee. . . . The Chair and the RSO are authorized to act for the Committee between regular meetings. (app. 7-2,3)

Radiation Safety Officer (RSO).

The RSO's duties and responsibilities include ensuring radiological safety and compliance with license conditions and applicable regulations. These duties and responsibilities include but are not limited to the following:

- Ensuring radiation safety and compliance with applicable regulations. . . .
- Performing preliminary reviews of requests for new uses and users, and discussing requests with the RSC. . . .
- Auditing use areas and individuals authorized to use byproduct material, to ensure compliance with USU's rules, its license, and applicable regulations. . . .
- Directing radiological waste management and disposal. . . .
- Monitoring personnel [researcher] exposure records, and developing corrective actions for exposures approaching maximum permissible limits. . . .
- Investigating incidents and responding to emergencies. (app. 7-7,8)

Radiation Safety Staff (Program Staff).

Program staff receive assignments from, and report to, the RSO. Program staff are trained appropriately to meet needs of the Program. (app. 7-8)

AUTHORIZING NEW USERS AND NEW USES

The Committee reviews requests for new authorizations or new uses, as well as requests for major modifications to existing authorizations. . . . The Committee may require additional information, controls, limitations, or restrictions before approving requests, or they may reject requests. (app. 7-6)

Required qualifications of applicants for [new] radiological research authorizations include:

- At least a bachelors degree, or equivalent training in a physical, biological, or engineering science relevant to their research projects.
- Training and experience in:
** Characteristics of ionizing radiation.*
** Biological hazards of radiation exposure.*
** Dose and activity measurement units.*
** Radiation detection instruments.*
** Radiation protection principles.*
** Safe handling of radiological materials, devices, or equipment comparable to those listed in their application. . . .*

Research applicants lacking some education or experience may be granted temporary AU status by the Committee. Either a current AU will oversee the applicant's research and provide relevant training, or the applicant may concurrently complete relevant courses and/or training. (app. 8-1)

PERMITTED USES OF RADIOACTIVE MATERIAL

Radioactive materials [may] be used for any purpose not prohibited by regulation or law, and consistent with the purpose and programs of Utah State University (USU), i.e., teaching, community services, and "research and development." (lic. 2)

Use of elements of special concern to regulators are generally prohibited. This includes depleted Uranium, Plutonium, enriched Uranium, Thorium and other elements closely associated with nuclear reactor fuels. *Authorization to possess radioactive materials with atomic numbers 84 through 96 does not authorize the possession of special nuclear material. (lic. 2)*

Before possessing elements of special concern we would need to develop controls for each research project, that pass regulatory review. However, we can possess natural and depleted Uranium in quantities below specific limits. Contact the RSO for more details.

Other restrictions include:

- The licensee shall not use licensed material in or on human beings except as provided otherwise by specific condition of this license. (lic. 7)
- This license does not authorize commercial distribution of licensed material, . . . or to persons exempt from licensing. (lic. 8)

PURCHASES / ACQUISITIONS

The RSO coordinates [acquisitions and transfers] of licensed dispensable radioactive material, . . . and sealed sources. Purchasing staff or automated purchasing systems

provide notification of order requests. Orders must be within limits authorized by the Committee. (app. 10-3)

Facilities Receiving is the default location for deliveries of radioactive material or devices. Program staff transport radioactive material packages to labs, except:

- Positron emission tomography (P.E.T.) isotopes with very short half-lives may be delivered directly to a lab.
- Certain static control and license exempt items may be delivered directly to SDL.

TRAINING

The RSO conducts a variety of radiological safety training classes designed to be relevant to [various] staff responsibilities and functions. Types of training include:

- *Authorized User orientation.*
- *Orientation relevant to lab type.*
- *Annual refresher relevant to lab type.*
- *Awareness relevant to support function. (app. 8-1)*

Refresher.

Annual refresher training is required for [researchers] . . . who intend to continue radiological work [research]. Refresher training includes review of lab violations and concerns, as well as changes to rules and/or regulations. (app. 8-2)

Awareness.

Awareness training for ancillary staff (custodial, crafts, etc.) who access labs includes instruction about hazard recognition and avoidance relevant to functions performed. (app. 8-3)

Lab specific safety training is provided and documented by AU's. (app. 8-2)

FACILITIES

The Program reviews radiological facilities and works with AU's to ensure adequate controls and safe working conditions are provided. Requests for use of new facilities are reviewed, and may be approved, by the RSO. (app. 9-1)

Facilities used for work with licensed dispensable materials need to be capable of restricting public access, limiting worker [researcher] exposure, and controlling contamination. (app. 9-1)

RADIATION SAFETY PROGRAM

USU's Radiation Safety Program (Program) provides support for radiological research. In addition to maintaining compliance with license requirements the Program facilitates research opportunities and lab safety

Program components presented above include the Committee, the RSO, training, and facilities. Information on other components is presented below.

Use / Storage of Material.

Use and storage of licensed radioactive material is normally limited to USU's campus research facilities and certain off-campus locations within the State of Utah. The Committee is responsible for approving use in new rooms, buildings, or locations. The RSO may approve changes to use areas within previously approved rooms.

Use on Federal lands, Native American lands, or in other states is generally prohibited, unless reciprocal recognition of licensing is arranged.

Caution Signs / Labels / Markings.

Radiation caution signs, labels, and markings (signage) are key indicators warning of potential exposure to material or emissions. Use of standardized symbols (graphics), text, and colors facilitates recognition of ionizing radiation hazards. The standard symbol is a trefoil (three bladed graphic) and may be accompanied by text such as "Caution, Radioactive Material." The most common color scheme is black graphic and lettering on yellow background. The original scheme was magenta (purplish red or reddish purple) on a yellow background, and is still acceptable. Similar text may be used with or without the trefoil.

Rooms or areas with only generally licensed or license exempt items do not need radiation caution signs.

Survey Instruments.

Lab survey instruments are used for discovering and resolving contamination. Instrument failures should be promptly resolved. The RSO may be able to provide temporary replacements.

The RSO reviews and approves survey instruments for Program use. (app. 10-1) Functionality of active survey instruments is reviewed at least annually.

Surveys and Leak Testing.

Labs that survey for contamination from dispensable tritium (3H) materials are required to use LSC wipe sample analysis.

Labs that survey for contamination from dispensable materials with higher emission energies than 3H must use portable count rate meters capable of effective detection, or LSC wipe sample analysis. (app. 10-6)

The Program surveys facilities, evaluates contamination, and performs bioassays in accordance with guidance in Appendix S of NUREG-1556, Vol. 11. (app. 10-5)

The Program inventories sealed sources and leak-tests them for source integrity regularly, generally every 6 months.

Occupational Dose.

A key principle of radiation safety is to reduce dose or exposure to as low as reasonably achievable (ALARA) levels. Additional information on occupational dose is provided in Appendix E-Dose Monitoring.

The Radiation Safety Committee continues to direct the Program to provide monitoring (dosimetry) of certain personnel with greater likelihood of occupational doses. . . .

The Program [also] monitors quantities of individual and lab uses of dispensable materials to determine when internal monitoring (bioassay) would be required. (app. 10-5)

Public Dose.

The Program reviews proposed and existing radiological work areas for public dose concerns. Dose fields are measured or calculated, or both, to verify public dose is within regulatory limits. Access restrictions, shielding, or other safety measures are applied as necessary to limit public exposures. (app. 10-5)

Transportation.

The Program complies with applicable USNRC, USDOT, and ICAO (IATA) transportation rules and regulations when transporting licensed radiological items on or off campus. (app. 10-7)

Program Audits.

Audits of the Program are conducted annually by the Committee. . . . Audits are intended to identify areas of weakness or noncompliance in the Program. . . . Program staff support and facilitate audits. (app. 10-1)

WASTE MANAGEMENT

The Program adheres to applicable local, state, and federal regulations regarding handling, transport, and disposal of radiological wastes. Only radiological waste from USU's licensed activities are accepted. Waste handlers receive training appropriate for their duties. Active waste containers are maintained in controlled lab spaces. Closed waste containers are transferred to storage. . . .

Wastes are segregated by similar characteristics and isotope half-lives. . . . [S]egregation begins as wastes are generated in labs . . . [and] includes short-lived and long-lived categories, and dry/solid, liquid, and scintillation sub-categories. (app. 11-1)

Short-Lived Waste.

Short-lived wastes are held in storage to allow activity to decay to levels indistinguishable from background in accordance with license conditions. Short-lived wastes only contain radioactive materials with half-lives of less than 120 days. A common holding period is 10 times the isotope's half-life. (app. 11-1)

Long-Lived Waste.

Long-lived wastes are held for consolidation or other licensed disposal activities. . . . Aqueous liquid wastes are reduced to dry/solids by passive evaporation. Disposal by USU's incinerator may be used for animal bodies or other wastes that meet specific activity limits and regulatory criteria. (app. 11-2)

APPENDIX A - DISPENSABLE MATERIAL INSTRUCTIONS / RULES

AUTHORIZED USERS AND LABORATORY SUPERVISORS

Authorized Users (AU's) and laboratory supervisors are responsible for radiological safety and security associated with their labs and research activities. They are expected to:

- Encourage lab safety and security.
  - * Provide effective training and written instructions, maintain markings and postings, and establish appropriate controls in labs.
- Maintain contamination control.
  - * Encourage thorough surveys and decontamination.
- Maintain complete and accurate Program related records.
  - * Encourage prompt recording of contamination surveys, material uses, waste disposal data, etc...
- Use established systems for ordering.
  - * Use the radiological material/equipment automated purchasing system, or directly involve the RSO.
- Promptly contact the RSO if significant events occur.
  - * Human contamination, major spill (1 mCi, 37 MBq, or more), and fixed contamination all require RSO involvement.
- Coordinate with the RSO well in advance of special radiological needs.
  - * 'Mixed' waste (e.g. radiological and biological or hazardous chemical) tends to be expensive and problematic.
  - * Adding authorization to possess new sealed sources or elements of special regulatory concern can take several months or more.
  - * Intended volatilization of radioactive material, or use of radio-labeled gases, require special controls to capture releases, and possibly license amendment.
- Request significant changes to research protocols well in advance of need.

SAFE USE

Common methods for minimizing or eliminating contamination or exposures include good lab hygiene, good lab technique, wearing appropriate personal protective equipment (PPE), and applying basic radiation protection methods.

Good lab hygiene includes effective hand washing (when entering and leaving the lab), effective contamination control, and thorough cleaning of known or potentially impacted items.

Good lab technique includes developing familiarity with handling and operating tools, supplies, and equipment, familiarity with appropriate uses for them, and efficient

organization of work areas.

PPE includes personal clothing that protects skin from direct impact by spills or splatters, as well as appropriate lab coat, safety eye wear, and gloves when handling a chemical.

Basic radiation protection methods encourage limiting time spent near radiation sources, increasing distance from them, and utilizing shielding when appropriate.

Similar to other worker or public safety controls, rules supporting lab safety developed over time, and are based on incidents, accidents, and increased understanding. Rules also facilitate control of contamination and exposure, since we can't directly sense (feel, see, or smell) radiation.

USU's basic lab safety rules are intended as minimums, and for most conditions. Additional controls may be necessary for various conditions.

Radioisotope Lab Safety.

- Personal activities must be avoided.
- Organize for effective and efficient operation.
- Identify contamination risks with markings and/or labels.
- Control and prevent contamination.
    * Wear PPE.
    * Use absorbent barriers on work surfaces.
    * Practice good lab hygiene.
    * Resolve concerns promptly.
    * Control splattering and fumes.
- Survey promptly after use and resolve contamination.
- Promptly discard wastes to designated containers.
    * Never dispose radioactive wastes or material to drains.
- Survey and decontaminate items before returning them to general use.
    * The RSO must approve returns of large items.
- Prevent public access to radioactive material or waste.
- If assigned, wear personal dose monitoring devices.
- Promptly report spills of 1 mCi, 37 MBq, or more, human contamination, or fixed contamination to the RSO.
- Maintain complete and accurate use, survey, and waste records.

CONTAINER LABELING

A container may be a vial, jar, tub, rack, or other device large enough to be individually labeled, or something that holds vials or tubes too small for individual labels. Radioactive labeling is required for containers with at least the following quantities of radioactive material. Other hazard labeling may also be required.

Container Labeling Limits (Label when activity meets or exceeds amount listed.)			
1,000 µCi (37 MBq)	100 µCi (3.7 MBq)	10 µCi (0.37 MBq)	1.0 µCi (37 kBq)
^{3}H (Tritium)	^{14}C	^{32}P	^{125}Iodine
	^{33}P		
	^{35}S		
	^{45}Ca		

For other isotopes contact the RSO.

Regulations instruct that containers have:

> *[A] durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label shall also provide information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, . . . {Utah Administrative Code R313-15-904, March 15, 2016}*

Before using marked/labeled containers in non-radiological work decontaminate them thoroughly and remove or deface markings/labeling.

RADIOACTIVE WASTE

Nothing in this portion relieves AU's of responsibility for complying with regulations governing toxic or hazardous substances that may be included in their radioactive wastes. Coordinate in advance with the RSO regarding special hazards or concerns that may be associated with wastes.

Use of dispensable radioactive material generates radioactive waste, at least in the form of project material and supplies. Contaminated tools, supplies, and equipment are also waste unless they are thoroughly decontaminated.

EH&S collects all radioactive wastes for disposal. USU is prohibited from releasing these wastes to public sewers or landfills. Program staff establish and remove standardized waste containers as needed. Waste log sheets are provided with containers so essential information on container contents can be recorded.

Radioactive wastes are currently separated into 2 major categories and 4 sub categories. The major categories are long-lived and short-lived isotopes. The primary sub categories are dry/solid, liquid, biological, and scintillation vial. The RSO may utilize other categories or sub-categories to facilitate waste management.

The following are USU's basic radioactive waste rules.

- Secondary containment is required for liquid containers.
- Special waste hazards (chemical, biological) require advance coordination.
- Containers must be marked and labeled.
    * Contact the RSO with marking/labeling concerns.
- Segregate wastes according to criteria on waste logs.
- Adjust acidic or basic liquids to a pH between 4 and 10.
- Do NOT overfill containers.
- Markings (tape, stickers, labels, etc.) that are free of contamination must be defaced before disposal in cold trash.
- Before pick-up, complete and sign waste logs.

Ready reference sheets (Quick Guides), outlining steps for waste related functions, are available from the RSO.

Dry / Solid.

Dry/Solid waste includes gloves, tips, absorbent paper, dry vials, and other material and supplies that are considered solid and lack significant amounts of liquid.

Segregate sharps, syringes, and broken glass into puncture proof/resistant containers.

Liquid.

Collect liquids that could be or are radioactive. This includes experiment solutions, rinses, washes, and significant amounts of solutions in vials or bottles.

Segregate liquids according to waste log criteria (e.g. aqueous, methanol, general liquids, etc.).

Scintillation Vial.

Scintillation vial wastes are vials with liquid scintillation cocktail in them. Other items with cocktail on them (gloves, tips, etc.) should be added to dry/solid waste.

Non-standard cocktail use (e.g. acetonitrile solutions) must be coordinated with the RSO.

Airborne.

Avoid creating airborne radioactive material. This can be an unusual exposure hazard to humans. Promptly report unintentional air releases to the RSO.

Research processes that might result in volatilization (e.g., fume, vapor) should be conducted in chemical fume hoods.

Biological.

Biologically hazardous wastes require special handling and controls. Coordinate use of biological hazards with the RSO.

AU's are responsible for neutralizing bio-hazards prior to EH&S waste disposal.

Biological waste containing short-lived radioactive material may be stored by AU's while activity decays away. Stored wastes should be in durable containers in frost free refrigeration, and labeled for easy retrieval and disposal. Prior to disposal, absence of radioactivity must be verified by Program staff.

Incineration of animal bodies, parts, or excreta containing limited amounts of radioactive material requires advance RSO approval.

Container Pick-up / Removal.

Request waste removal when one or more containers are full, or a project or phase is complete.

Preparation of waste containers includes:

- Updating waste log data.
- Recording total activity added to containers.
- Signing and dating logs.
- Closing boxes and/or tightening liquid caps.

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UtahStateUniversity

New Radio-Label Quick Guide

Is the Logsheet Present ?

No

Call the RSO 797-3514

Yes

Place material in storage.

If you survey inside the package,

. . . was there contamination?

Yes

No

Deface Labels and Recycle Box

Call the RSO 797-3514

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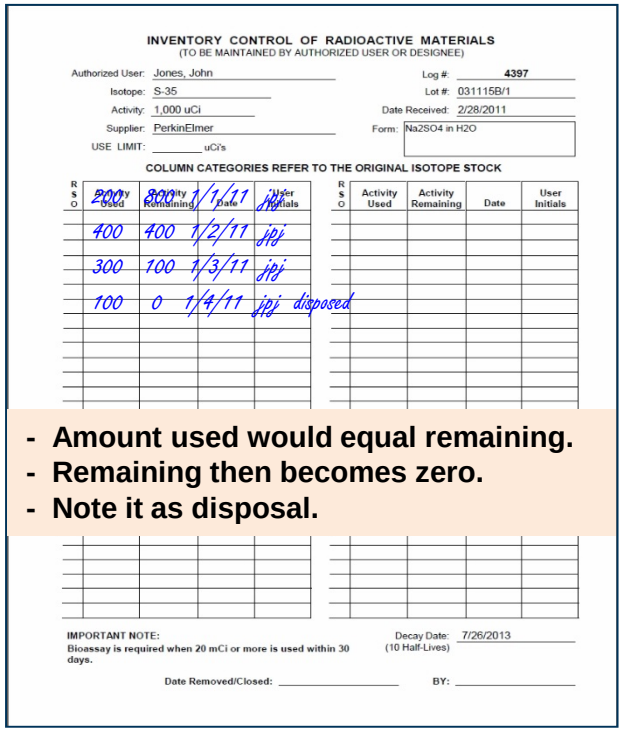
UtahStateUniversity

Radio-Label Close-Out Quick Guide

Finish the data entries.



INVENTORY CONTROL OF RADIOACTIVE MATERIALS
(TO BE MAINTAINED BY AUTHORIZED USER OR DESIGNEE)

Authorized User: Jones, John — Log #: 4397
Isotope: S-35 — Lot #: 031115B/1
Activity: 1,000 uCi — Date Received: 2/28/2011
Supplier: PerkinElmer — Form: Na2SO4 in H2O
USE LIMIT: _____ uCi's

COLUMN CATEGORIES REFER TO THE ORIGINAL ISOTOPE STOCK

RSO	Activity Used	Activity Remaining	Date	User Initials
	200	800	1/1/11	jpj
	400	400	1/2/11	jpj
	300	100	1/3/11	jpj
	100	0	1/4/11	jpj disposed

IMPORTANT NOTE:
Bioassay is required when 20 mCi or more is used within 30 days.

Decay Date: 7/26/2013
(10 Half-Lives)

Date Removed/Closed: _____ BY: _____

- **Amount used would equal remaining.**
- **Remaining then becomes zero.**
- **Note it as disposal.**

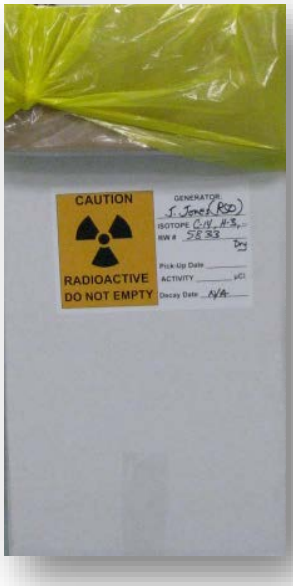
Is isotope half-life < 120 days?

No

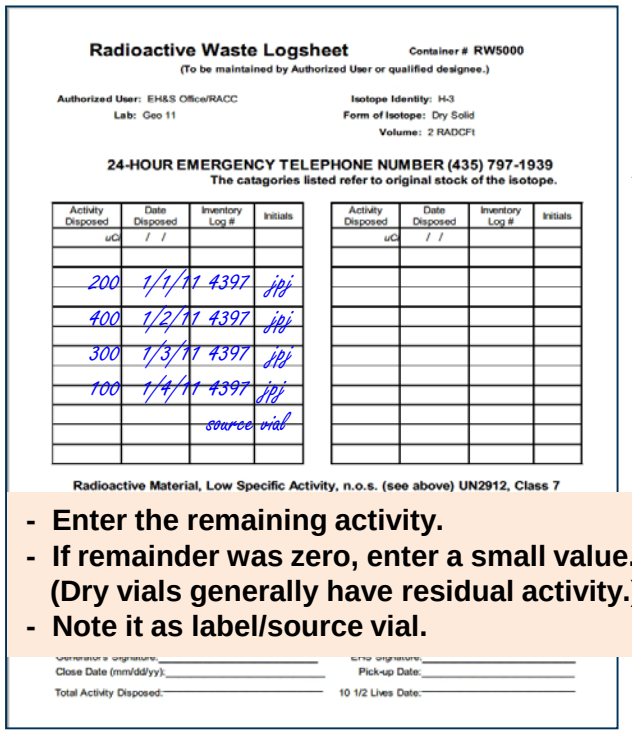
Yes

Deface Rad' markings.

Place in dry waste for the isotope.



Enter activity disposed on waste log.



Radioactive Waste Logsheet — Container # RW5000
(To be maintained by Authorized User or qualified designee.)

Authorized User: EH&S Office/RACC
Lab: Geo 11
Isotope Identity: H-3
Form of Isotope: Dry Solid
Volume: 2 RADCFI

24-HOUR EMERGENCY TELEPHONE NUMBER (435) 797-1939
The catagories listed refer to original stock of the isotope.

Activity Disposed	Date Disposed	Inventory Log #	Initials
uCi	/ /		
200	1/1/11	4397	jpj
400	1/2/11	4397	jpj
300	1/3/11	4397	jpj
100	1/4/11	4397	jpj
		source vial	

Radioactive Material, Low Specific Activity, n.o.s. (see above) UN2912, Class 7

Close Date (mm/dd/yy): _____ Pick-up Date: _____
Total Activity Disposed: _____ 10 1/2 Lives Date: _____

- **Enter the remaining activity.**
- **If remainder was zero, enter a small value. (Dry vials generally have residual activity.)**
- **Note it as label/source vial.**

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Liquid Waste Close-Out Quick Guide

When a container is full, or no longer needed, finish the data entries.

Sign and Date & Total the Activity

Tighten Caps to Prevent Leaks

Maintain Secondary Containment

Radioactive Waste Logsheet

Container # RW5000

(To be maintained by Authorized User or qualified designee.)

Authorized User: EH&S Office/RACC
Lab: Geo 11
Isotope Identity: H-3
Form of Isotope: Liquid
Volume: 5 RADGal

24-HOUR EMERGENCY TELEPHONE NUMBER (435) 797-1939
The catagories listed refer to original stock of the isotope.

Activity Disposed	Date Disposed	Inventory Log #	Initials
200 uCi	1/1/11	4397	jpj
400	1/2/11	4397	jpj
300	1/3/11	4397	jpj
100	1/4/11	4397	jpj

Activity Disposed	Date Disposed	Inventory Log #	Initials
uCi	/ /		

Radioactive Material, Low Specific Activity, n.o.s. (see above) UN2912, Class 7
This is to certify that the contents of this consignment are fully and accurately described herein, and are, in all respects, in proper condtion for transportation.

Consignor: *Name:*EH&S Office/RACC
*Office:*ECOB 128
*Phone:*7-2892
*UMC:*8315, Old Main Hill
Logan, Utah 84322-8315

Consignee: Environmental Health and Safety
Utah State University
(Radioactive Waste Storage Facility)
(Motor Pool Complex)
900 East 1400 North
Logan, UT 84322

As generator, I certify that the information reported on this logsheet is an accurate representation of all wastes in this container, and that all constituents have been declared.

Generator's Signature:_____
Close Date (mm/dd/yy):_____
Total Activity Disposed:_____

EHS Signature:_____
Pick-up Date:_____
10 1/2 Lives Date:_____

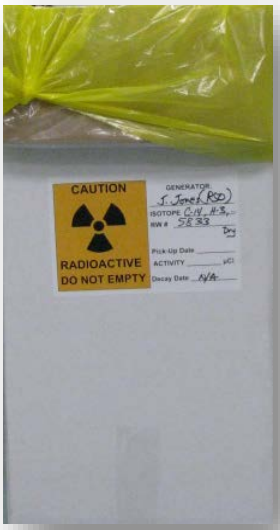
Request Pick-Up

Website
rgs.usu.edu/ehs/

E-mail
john.p.jones@usu.edu

Phone
797-3514

Solid Waste Close-Out Quick Guide

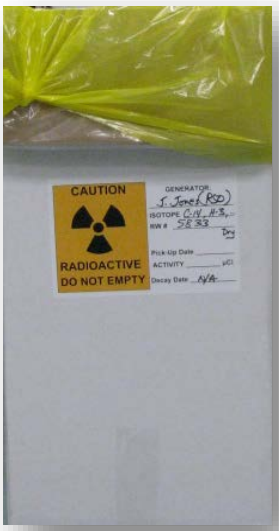


When a container is full, or no longer needed, finish the data entries.

Sign and Date & Total the Activity

Close Each Liner

Close Box Flaps



Radioactive Waste Logsheet

Container # RW5000

(To be maintained by Authorized User or qualified designee.)

Authorized User: EH&S Office/RACC
Lab: Geo 11
Isotope Identity: H-3
Form of Isotope: Dry Solid
Volume: 2 RADCFt

24-HOUR EMERGENCY TELEPHONE NUMBER (435) 797-1939
The catagories listed refer to original stock of the isotope.

Activity Disposed	Date Disposed	Inventory Log #	Initials
200 uCi	1/1/11	4397	jpj
400	1/2/11	4397	jpj
~~300~~	~~1/3/11~~	~~4397~~	~~jpj~~
100	1/4/11	4397	jpj

Activity Disposed	Date Disposed	Inventory Log #	Initials
uCi	/ /		

Radioactive Material, Low Specific Activity, n.o.s. (see above) UN2912, Class 7
This is to certify that the contents of this consignment are fully and accurately described herein, and are, in all respects, in proper condtion for transportation.

Consignor: *Name:*EH&S Office/RACC
*Office:*ECOB 128
*Phone:*7-2892
*UMC:*8315, Old Main Hill
Logan, Utah 84322-8315

Consignee: Environmental Health and Safety
Utah State University
(Radioactive Waste Storage Facility)
(Motor Pool Complex)
900 East 1400 North
Logan, UT 84322

As generator, I certify that the information reported on this logsheet is an accurate representation of all wastes in this container, and that all constituents have been declared.

Generator's Signature:_____
Close Date (mm/dd/yy):_____
Total Activity Disposed:_____

EHS Signature:_____
Pick-up Date:_____
10 1/2 Lives Date:_____

Request Pick-Up

Website
rgs.usu.edu/ehs/

E-mail
john.p.jones@usu.edu

Phone
797-3514

APPENDIX B - NUCLEAR GAUGE INSTRUCTIONS / RULES

NUCLEAR GAUGES

Nuclear gauges at USU are portable and use sealed radioactive sources for soil-moisture or compaction analysis. Nuclear gauges are regulated by the DWMRC, EPA, and DOT. The following rules are based on regulations, as well as statements made in support of USU's license.

Nuclear Gauge Safety.

- Researchers must have successfully completed initial safety training and be current with annual refresher training.
- Researchers must wear assigned dosimetry during transport and use of gauges.
- Dosimetry not in-use must be stored away from gauges and in an area with low background radiation.
- Except when in use (e.g. during transport or while in storage):
  Each portable gauge licensee shall use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal. {Utah Administrative Code R313-19-34(9), March 15, 2016}
- During transport:
  * Occupancy of vehicles is limited to researchers.
  * Gauges must be located away from researchers.
  * Gauges must be in their assigned DOT shipping case, with required labels and markings in good condition.
  * Gauges must be effectively blocked against movement.
  * Researchers must maintain ready access to:
    ~ The Shipping Paper (a.k.a, Manifest)
    ~ Emergency Response Information
    ~ Gauge Registration Information
  * Documentation must be on the seat next to the driver, or in a holder on the driver's door.
- When a researcher is not with the transport vehicle:
  * For closed vehicles (cars, vans), gauge cases must be locked and the vehicle locked.
  * For truck beds, gauge cases must be locked and cases must be securely fastened and locked to the bed of the truck.
- During use, researchers must maintain ready access to the operators/users manual.
- Records of gauge use must include dates of use, use locations, and researchers names.
- Each gauge must have a permanent storage location.
- *[Gauge] cleaning, maintenance, or repair . . . that requires the source rod to be*

out of the safe, shielded position, . . . shall be performed only by the manufacturer or by other persons specifically licensed . . . to perform such services. (lic. 6)
- *[Gauges] may be used at temporary job sites of the licensee anywhere in the State of Utah where the [DWMRC] maintains jurisdiction (lic. 3)*, or at other job sites in or outside the State of Utah where a reciprocal recognition of license (reciprocity) is arranged with jurisdiction authorities.

Facilities.

Facilities used in association with licensed nuclear gauges need to be capable of restricting public access and limiting worker and public exposure. Review criteria include:

- *Storage locations with two independent physical controls to prevent removal.*
- *Storage locations that reduce human exposure to ALARA levels within regulatory limits.*
- *Road transport vehicles with two independent physical controls to prevent removal. (app. 9-2)*

The RSO provides manufacturer equivalent safety training as well as inspections of permanent storage locations and leak testing.

The RSO coordinates gauge transfers to researchers and repair contractors, as well as reciprocity with alternate jurisdiction authorities.

APPENDIX C - SEALED SOURCES AND OTHER RADIOACTIVE ITEMS INSTRUCTIONS / RULES

SEALED SOURCES AND OTHER RADIOACTIVE ITEMS

Devices or equipment designed to provide or produce ionizing radiation, but not allow dispensing of material, are regulated based on related safety concerns.

- Acquisition of devices must be coordinated with the RSO.
- Some devices require Committee authorization prior to acquisition.
- Some devices require license amendment prior to acquisition.
- Program staff inspect devices prior to initial use.

Device owners are to:

- Coordinate device location changes and transfers with the RSO.
- Coordinate repair and/or disposal with the RSO.
- Prevent public access to and maintain control of devices.
- Promptly report suspected or known damage to the RSO.

Gas chromatographs with ECD's, generally licensed items, and license exempt items are excluded from project review, though safety, accountability, and security responsibilities remain.

Sealed Sources.

Radioactive devices that meet specific regulatory criteria are named sealed sources. They contain radioactive material that is permanently bonded to a surface, fixed in a capsule, or fixed in a matrix. They are designed to prevent release of material at least during normal use.

Call the RSO immediately if a sealed source is damaged or suspected of leaking. Though sealed sources are considered sealed or fixed, they can begin to leak when exposed to unusual conditions. Leaking sealed sources must be immediately removed from use.

Sealed source owners are to:

- Use sources according to manufacturer instructions and/or Committee authorized procedures.
- Maintain manufacturer radiation warning or caution markings, and report incomplete or missing markings to the RSO.
- Rely on remote manipulation as the preferred method for handling.
- Avoid direct contact with the more active face/surface.
- Make sources readily available for regular leak testing.

Generally Licensed and License Exempt Items.

Generally licensed item design usually allows for direct handling, though some personal protection or separation is at least recommended. Though they are termed generally licensed, our license requires various controls regarding them.

- Generally licensed items may or may not also meet sealed source criteria.
- Avoid direct contact with the more active face/surface.
- Generally licensed items are regularly inventoried.

License exempt items present the least concern and require the least controls. Though they are termed license exempt, our license requires various controls regarding them.

- License exempt items can be handled directly, though some personal protection or separation is at least recommended.
- Avoid direct contact with the more active face/surface.

Promptly report damage or indications of leakage to the RSO. Slight changes in amount of emissions may indicate damage or leakage.

APPENDIX D - X-RAY EQUIPMENT INSTRUCTIONS / RULES

X-RAY EQUIPMENT

X-Ray producing equipment is registered with regulators independently of a radioactive material license. X-Ray equipment rules and controls are also somewhat different from those applicable to radioactive material use. Common concerns include limiting dose or exposure, preventing public access, and appropriate use.

Equipment designed to produce X-Rays does so by directing high energy electrons at a target in a vacuum. X-Ray radiation exists when power to the tube is on.

Depending on design and age, various safety components that prevent unnecessary exposure are required to be integral to equipment construction. Warning lights, safety interlocks, beam stops, shielding, and collimators can commonly be required as part of equipment operation.

Principle investigators (PI's) responsible for equipment are to:

- Coordinate acquisitions in advance with the Committee and RSO.
- Coordinate changes in location, ownership, or disposition of equipment in advance with the RSO.
- Provide equipment specific training to researchers, and maintain training records.
- Provide written operating procedures for researchers.
- Determine when researchers are capable of using equipment independently.

X-Ray safety rules must be posted or readily available near equipment. Standard rules are listed below. If modifications to standard rules are desired, they must be approved by the RSO before application.

X-Ray Safety.

- Prevent public access to X-Ray equipment.
- If assigned, wear personal dosimetry.
- If assigned, use lead (Pb) gloves, aprons, or other shielding.
- Only use approved methods for operating equipment.
- Verify that X-Ray tube power is off, or emissions are effectively shielded, before changing samples.
- For veterinary X-Ray imaging, *[i]f the animal must be held by an individual, . . . [t]he individual shall be so positioned that no unshielded part of that individual's body will be struck by the useful beam. {Utah Administrative Code R313-35-110(d), May 22, 2015}*
- If accidental exposure is suspected or occurs, contact the RSO immediately.
- If X-Ray leakage is suspected, contact the RSO immediately.

- Never bypass safety interlocks.
- In-house repair that would involve removal of protective covers, requires advance Committee authorization.

Equipment repair should be performed by certified technicians. In-house repair efforts require Committee approval in advance if such efforts could present increased exposure risk.

Program staff conduct surveys of X-Ray equipment as needed.

APPENDIX E - DOSE MONITORING INSTRUCTIONS / RULES

DOSIMETRY

Regulations require a personnel dose monitoring program when worker (researcher) exposures could reasonably exceed 10% of regulatory limits. Though dose at USU has been and is expected to remain well below action limits, the Committee directs that certain conditions be monitored. The following table lists minimum conditions for monitoring, and the RSO is allowed to expand efforts.

RADIATION TYPE & QUANTITY	DOSIMETRY
Dispensable High Energy Beta (e.g. ^{32}P) Monthly or one-time use > 1 mCi (37 MBq)	Extremity
Dispensable Gamma/X-Ray (non-RIA kit) Monthly or one-time use > 0.25 mCi (9.25 MBq)	Whole Body & Extremity
Open Beam X-Ray Equipment	Whole Body & Extremity
Nuclear Gauge (Neutron emissions)	Whole Body

Proper use and care of dosimetry is the responsibility of researchers. It should be worn when conducting radiological research. It should be protected from contamination (radiological, chemical, or biological). It should be stored away from licensed sources of radiation and in relatively low background radiation conditions. It should be available to Program staff when exchanging new dosimetry for old.

Dosimetry should be positioned between radiation sources and the body. Extremity dosimetry should be on the hand most likely to be exposed and faced toward the source. Body dosimetry should be on the front of the body between the collar and belt lines and faced toward the source. The RSO may direct other placements.

BIOASSAYS (INTERNAL MONITORING)

Bioassays can be used to determine whether or not radioactive material has been internalized. They generally involve analyzing samples of body fluids or measuring radiation emissions from the body.

Bioassays can be required if internalization occurs or is suspected. Internalization may occur by:

- Inhalation of volatile or volatilized material,
- Ingestion of material from contaminated surfaces,
- Absorption of material through skin, or
- Injection of material through skin.

A bioassay is required when a researcher's use of isotope exceeds certain levels. For common isotopes, the table below lists minimum levels that would create a need for bioassay.

BIOASSAY CRITERIA (mCi / MBq)		
Isotope	ALI	Use per Month
^{3} H (Tritium)	80 / 2960	10 / 370
^{14} Carbon	2 / 74	10 / 370
^{32} Phosphorus	0.4 / 14.8	4 / 148
^{35} Sulfur	2 / 74	20 / 740
^{45} Calcium	0.4 / 14.8	4 / 148
^{125} Iodine, bound	0.3 / 11.1	10 / 370

Researchers are encouraged to use material bound in a compound or that has low volatility because it is much less likely to be internalized. Minimization of activity needed for experiments is also encouraged.

DOSE LIMITS

Regulations limit annual researcher dose or exposure to licensed sources of ionizing radiation. Limits can vary according to age and body part exposed. Commonly referenced limits for researchers are listed in the table below.

ANNUAL OCCUPATIONAL DOSE LIMITS	
TISSUE	rem / mSv
Trunk of the Body	5 / 50
Eyes	15 / 150
Skin Only (Shallow)	50 / 500
Body Extremity	50 / 500
Embryo / Fetus	0.5 / 5

[Note: Arms above the elbow or legs above the knee are part of the "whole body" and are not to be considered in extremity measurements.]

Individuals younger than 18 years are considered minors and may participate in radiological research at USU. Because dose limits for researchers that are minors are one tenth (1/10th) adult limits, the Committee reviews conditions before minors are allowed to participate. Affected labs may be required to implement modifications to adequately protect researchers that are minors.

Some concerns and options regarding pregnant workers (researchers) are found in the following excerpts from NRC Regulatory Guide 8.13.

This guide is intended to provide information to pregnant women, and other personnel, to help them make decisions regarding radiation exposure during pregnancy. . . . (1)

A declared pregnant woman is . . . a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. . . . (1)

A lower dose limit for the embryo/fetus . . . is based on a consideration of greater sensitivity . . . and the involuntary nature of the exposure. . . . (3)

The choice whether to declare your pregnancy is completely voluntary. . . . (5)

[C]an I revoke my declaration of pregnancy even if I am still pregnant? Yes, you may. . . (8)

[USU is required to] ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). (1)

Basic dose limits for members of the public are 2 mrem (0.02 mSv) per hour and 100 mrem (1 mSv) per year. Members of the public also include researchers not qualified to work with ionizing radiation and those not directly associated with the lab where dose might occur. The following statements on public dose are part of USU's current license.

The Program reviews proposed and existing radiological work areas for public dose concerns. Dose fields are measured or calculated, or both, to verify public dose is within regulatory limits. Access restrictions, shielding, or other safety measures are applied as necessary to limit public exposures. (app. 10-5)

DOSE RECORDS

Dose records are developed and maintained for researchers assigned dosimetry. The RSO provides annual dose/exposure reports to researchers receiving more than 100 milli-rem total effective dose equivalent in the calendar year. Dose histories are available from the RSO.

APPENDIX F - SPILL / EMERGENCY INSTRUCTIONS / RULES

SPILLS

Most spills in labs at USU tend to differ from emergencies in that they generally lack significant danger or need for immediate action. They tend to require prompt attention, and may be stressful, but should be resolvable with relatively little effort and concern.

Spills of radioactive material are generally preventable and should be rare occurrences. Yet, they are possible wherever materials are used, manipulated, stored, moved, or transported. Rules for response to spills tend to be generic, and are provided below.

Minor Spills. (less than 1 mCi, or 37 MBq)

When less than 1 mCi (37 MBq) of radioactivity is spilled the event is considered a minor spill. Generally, minor spills can be resolved by researchers. Commonly they include splatters, drips, or smears of material on a surface.

Spill clean-up may be more effective with team effort. Trained lab partners can help by cleaning, reviewing efforts, gathering supplies, or aiding containment. Program staff are also available to help resolve spills.

Basic Minor Spill Response.

- Replace or add PPE as needed.
- Contact the RSO promptly regarding human contamination (inhalation, ingestion, or skin contamination).
- Contact the RSO promptly if material becomes airborne (fume, vapor, etc.). Also see Airborne Releases below.
- Contain liquids promptly with adequate absorbents.
- Determine the extent of areas affected by contamination.
- Limit access to known and suspected contaminated areas.
- Isolate contaminated PPE, shoes, clothing, etc..
- Clean areas starting at outside edges and working toward centers.
- When reasonable, use remote manipulation for cleaning or collecting contaminated items.
- Verify decontamination by surveying.
    * Wipe samples must be used when ^{3}H is spilled.
    * Portable meters can be used for most isotopes.
    * Decontamination is effective when wipe sample results are below 100 DPM or meter readings are below 3 times background.
- Wash hands and perform personal surveys when finished.
- Report fixed contamination to the RSO.
- Record relevant data and descriptions.

Only Program staff are allowed to use destructive methods for decontamination (sanding, peeling, strong solvents, etc.).

Currently, USU doesn't use dry dispensable material, however dry spills or releases may occur during grinding or similar manipulation of dry or solid radioactive material. It's important to note that:

Fine dry particles may mix with aerosols, natural dusts, etc., and slight air movement can disperse fine particles.

Generally, minor dry spills can be collected with lab tape. Other basic minor spill response steps mentioned above may be useful as well.

Major Spills. (1 mCi, 37 MBq, or more)

When 1 mCi (37 MBq) or more of radioactivity is spilled the event is considered a major spill. The RSO needs to manage response to major spills.

Basic Major Spill Response.

- Replace or add PPE as needed.
- Contact the RSO promptly.
- Contain liquids promptly with adequate absorbents.
- Move, with co-workers, to a safe distance.
- Isolate contaminated PPE, shoes, clothing, etc..
- Limit access to suspected contaminated areas.
- Detain potentially contaminated individuals.
- Record relevant data and descriptions.

Safe distances from spilled activity depend on emission energies and compound volatility. Low energy emissions (from ^{14}C) travel at most about 15 cm in air. Compounds with low volatility at usual room temperatures should remain in liquid form.

AIRBORNE RELEASES

Airborne release of material could result in radioactive fumes, mists, vapors, gases, aerosols, or dusts. Material may become airborne if it is volatile, overheated, or involved in fire or explosion.

Basic Airborne Release Response.

- While moving to a safe location try to use simple breathing filters (e.g. tissue paper, paper towel, cloth, etc...).
- If safe and easy to do disable the source of release.

- If safe and easy to do turn off air handling equipment.
- Call campus 911 and report:
  Your name,
  Incident location,
  Injury status,
  That the HVAC system should be shut down, and
  Other relevant information.
- If HVAC systems remain on it may be necessary to evacuate the building.
- Try to move affected individuals to a clean and safe area (possibly a restroom).
- Try to prevent access to affected rooms.
- Record relevant data and descriptions.

HUMAN INGESTION

Significant human ingestion of material presents unusual concerns and any such events must be addressed promptly.

Basic Human Ingestion Response.

- Try to move affected persons to a clean and safe area (possibly a restroom).
- Remain with affected persons as much as possible.
- Call campus 911 and report:
  Your name,
  Incident location,
  Injury status, and
  Other relevant information.
- If instructed to induce vomiting try to retain body fluids.
- Record relevant data and descriptions.

INJURIES

Human injuries may need more than just first aid. Professional medical care and monitoring may be required to limit or prevent possible effects.

Basic Injury Response.

- Prompt medical care should be provided.
- If campus 911 is called, report:
  Your name,
  Incident location,
  Injury status, and
  Other relevant information.
- If material gets in eyes use an eye wash station, or clean warm water.
- Consider rinsing wounds containing radioactive material with clean warm

water.
- Contact the RSO promptly.
- Record relevant data and descriptions.

EMERGENCIES

Personal safety in an emergency can depend heavily on familiarity with basic plans and actions designed to preserve lives. In an emergency, you should:

- First, protect yourself, by following basic safety plans or routines designed for the type of incident.
- Second, protect or aid others, if it won't endanger yourself, by offering help in following basic safety plans or routines designed for the type of incident.

Fire.

USU's emergency response plans should be implemented if a lab or building fire occurs. Evacuation and activating a fire alarm are key actions.

Promptly report fires that involve or may involve radioactive materials to the RSO.

If injuries occur, refer to Basic Injury Response above.

Explosion.

USU's emergency response plans should be implemented if an explosion occurs. Evacuation and reporting are key actions.

Promptly report explosions that involve or may involve radioactive materials to the RSO.

If injuries occur, refer to Basic Injury Response above.

Bomb Threats.

USU's emergency response plans should be implemented in the event of a bomb threat. Reporting and following instructions from emergency personnel are key actions.

Promptly report bomb threats that may involve radioactive materials to the RSO.

Basic Emergency Response.

- Incidents are received and recorded by 911 operators.

- 911 operators notify local emergency agencies and responsible officials necessary for response to and incident.
- Emergency response plans are implemented as conditions warrant.
- Incident command structure is implemented as conditions warrant.

Program Staff.

- Program staff respond to radiological incidents and report to Incident Commanders, or responsible officials.
- Program staff act as advisors to Incident Commanders, or responsible officials, until an incident is brought to an acceptable outcome, or until relieved by a superior advisor.
- Program staff assess radioactive concerns and advise Incident Commanders, or responsible officials, on appropriate responses.
- The RSO and/or Program staff may advise emergency responders and/or may assume primary responsibility for:
    * Advising responders regarding radiation hazards.
    * Directing emergency response regarding radiation hazards.
    * Overseeing radioactive cleanup and decontamination.
    * Reporting radioactive material events to regulatory authorities.

APPENDIX G - DEFINITIONS AND REFERENCES

DEFINITIONS

ACTIVITY generally refers to numbers of ionizing radiation emissions per unit of time. Common units of activity are CPM (counts per minute), DPM (disintegrations per minute), Curies, and Becquerels.

ALI (ANNUAL LIMIT on INTAKE) is a derived annual limit for a researcher's internalization or uptake of a radio-isotope, and values vary by isotope. One ALI is calculated to result in a dose of 5 rem (0.05 Sv) in a year, which would meet a researcher's annual whole body limit.

AS LOW AS REASONABLY ACHIEVABLE (ALARA) is a regulatory principle that requires limiting human exposure, with an understanding that some dose may not be preventable and/or may not present significant concern.

> *(ALARA) means . . . as far below the dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations. {Utah Administrative Code R313-12-3, June 16, 2015}*

AUTHORIZED USER (AU) is a person authorized by the Committee to conduct research that utilizes ionizing radiation.

BACKGROUND RADIATION refers to naturally occurring or other ubiquitous emissions, not from licensed material or devices.

BECQUEREL (Bq) is a unit of measure for activity or radioactivity. It's basis 1 DPS (disintegrations/decays per second), or 60 DPM (disintegrations/decays per minute).

> MBq refers to mega-Becquerel, or one thousand Becquerels.

BETA RADIATION refers to ionizing electron particle emissions.

BIOASSAY refers to sampling and analysis of body fluids, and/or tissues, for the presence of radioactive material.

BIOLOGICAL HALF-LIFE is a time period in which the body is expected to eliminate half of an internalized radio-isotope. Time periods vary relative to isotope and physiological conditions.

COLD can refer to absence of radioactive material.

CONTAMINATION refers to radioactive material on surfaces, or in locations, where it's not desired or useful, and not readily recoverable.

CONTAINER is a holder or carrier. Containers can also be tubs or racks used for holding smaller containers that are difficult to transport, mark, or label.

CURIE (Ci) is a unit of measure for activity or radioactivity. It's based on the rate of emissions from 1 gram of Radium-226, and is defined as 37 billion DPS (disintegrations/decays per second), or 2.22 trillion DPM (disintegrations/decays per minute).

mCi refers to milli-Curie, or one thousandth of a Curie.

DECAY refers to reduction in amount of radioactive material over time due to ionizing radiation emissions. Radioactive atoms become lighter elements or isotopes by emitting or ejecting ionizing photons or particles.

DECONTAMINATE / DECONTAMINATION refers to efforts to remove radioactive contamination from a person, place, or thing.

DOSE refers to exposure to, or impact from, ionizing radiation emissions.

DOSE LIMIT is an upper bound of allowed human radiation exposure or dose. Limits vary relative to sensitivity of potentially impacted tissue, or to function.

EMISSIONS refer to ionizing radiation photons or particles emitted or ejected from radioactive material or radiation producing devices.

ENVIRONMENTAL HEALTH AND SAFETY (EH&S) *is a service organization that provides expertise and advice for compliance with federal, state and local safety and health regulations, as well as current professional practices and guidelines. {USU EH&S web pages.}*

EMBRYO / FETUS refers to a developing human prior to birth.

EXPOSURE refers to impact from ionizing radiation. (Also see dose.)

EXTREMITY is a regulatory term referring to the portions of the body below the elbows and below the knees, and to the skin. All skin is an extremity if emissions are expected to stop travel within its layers.

GAMMA RADIATION (GAMMA RAYS) refer(s) to ionizing photon emissions originating from an atom's nucleus.

GENERALLY LICENSED ITEMS contain radioactive material and are authorized by regulations for possession by the general public. They are essentially considered safe

for public use if they remain intact. (Also see federal regulation 10CFR31.)

HALF-LIFE is a time period over which a radio-isotope decays or degrades to half its original activity or emission rate. Also, half of the original radio-isotope would become another element or isotope.

HOT can refer to the presence of radioactive material.

INTERLOCK is a device that prevents potentially hazardous internal equipment components from fully functioning when a protective cover is removed.

IONIZING RADIATION refers to photon or particle emissions with enough energy to remove electrons from their normal orbits around atoms.

LABORATORY SUPERVISOR is a key assistant to an Authorized User (AU), who would manage research staff and/or lab operation.

LEAK TEST is a process of sampling a Sealed Source to verify its integrity.

LEAKAGE refers to release of radioactive material from a container or Sealed Source, or of X-Ray emissions passing from equipment into a surrounding area.

MONITORING refers to searching for, sampling, and/or measuring potential or actual human exposure to ionizing radiation.

OCCUPATIONAL DOSE is exposure/dose to a researcher while they use licensed sources of ionizing radiation. Specific exclusions to this include exposures from background radiation, medical procedures, being a subject in research studies, or being a member of the general public.

PARTICIPATING PERSONNEL are lab or research staff trained and allowed to use licensed or registered sources of ionizing radiation under the direction of their AU and/or Lab Supervisor.

PROJECT refers to a research activity that utilizes licensed sources of ionizing radiation.

PUBLIC DOSE is exposure/dose to a member of the public from licensed sources of ionizing radiation. Exposure to background radiation, during medical procedures, and from being a subject in research studies are not considered part of public dose.

RADIATION or RADIOACTIVITY refers to ionizing radiation emissions.

RADIATION SAFETY COMMITTEE (Committee) is the quorum of individuals responsible for oversight of radiation safety and the Radiation Safety Program at USU.

RADIATION SAFETY OFFICER (RSO) is the individual responsible for daily management of radiation safety and the Radiation Safety Program at USU.

RADIATION SAFETY PROGRAM (PROGRAM) refers to USU's efforts to establish and maintain compliance with relevant federal, state, and local safety and health regulations.

RADIOLOGICAL refers to efforts involving, or items associated with, licensed sources of ionizing radiation.

REM is a dose unit indicating potential relative biological effect on humans (mammals) for various types of radiation emissions. One hundred rem equals 1 Sv.

RESEARCHER can refer to participating personnel, lab supervisors, and authorized users.

SEALED SOURCE is an item containing radioactive material that is essentially permanently bonded or fixed in place. The item's design is intended to prevent release or dispersal of the material under normal conditions. Such items must meet regulatory and manufacturer license criteria.

SIEVERT (Sv) is a dose unit indicating potential relative biological effect on humans (mammals) for various types of radiation emissions. One Sv equals 100 rem.

TOTAL EFFECTIVE DOSE EQUIVALENT *(TEDE) means the sum of the effective dose equivalent [EDE] for external exposures and the committed effective dose equivalent for internal exposures. {Utah Administrative Code R313-12-3, June 16, 2015}*

WHOLE BODY is a regulatory term referring to the more radio-sensitive parts of the human body. The head, trunk, arms above the elbow, and legs above the knee are included.

X-RADIATION (X-RAYS) refers to ionizing photon emissions originating from electron shells or clouds of atoms. They are most commonly associated with equipment that produces X-Rays, such as medical or sample analysis units.

REFERENCES

Utah Division of Waste Management and Radiation Control (DWMRC)

R313-12	General Provisions
R313-15	Standards for Protection Against Radiation
R313-18	Notices, Instructions and Reports to Workers by Licensees or Registrants -- Inspections
R313-19	Requirements of General Applicability to Licensing of

	Radioactive Material
R313-21	General Licenses
R313-22	Specific Licenses
R313-16	General Requirements Applicable to the Installation, Registration, Inspection, and Use of Radiation Machines
R313-35	Requirements for X-Ray Equipment Used for Non-Medical Applications

United States Nuclear Regulatory Commission (NRC)

10CFR 19	Notices, Instructions and Reports to Workers: Inspection and Investigations
10CFR 20	Standards for Protection Against Radiation
10CFR 30	Rules of General Applicability to Domestic Licensing of Byproduct Material
10CFR 31	General Domestic Licenses for Byproduct Material
10CFR 33	Specific Domestic Licenses of Broad Scope for Byproduct Material
NUREG-1556 v.11	Consolidated Guidance About Materials Licenses
Reg. Guide 8.25	Air Sampling in the Workplace

United States Department of Transportation (DOT)

49CFR 100-177	Other Regulations Relating to Transportation (Pipeline and Hazardous Materials Safety Administration)

National Council on Radiation Protection and Measurements (NCRP)

Report No. 127	Operational Radiation Safety Program
Report No. 157	Radiation Protection in Educational Institutions

American National Standards Institute (ANSI)

N323-1978	American National Standard Radiation Protection Instrumentation Test and Calibration