# RPR 54
# RADIOACTIVE WASTE MANAGEMENT

## PURPOSE

This procedure specifies how the Radiological Health Department collects, stores, processes, packages, and disposes of radioactive waste.

## POLICY

All users of radioactive materials must be trained in the process of segregating, packaging, and communicating information about radioactive waste. All users are encouraged to minimize, by volume and mass, their generation of radioactive waste. Users are further encouraged to avoid generating mixed waste, if possible, and to minimize unavoidable mixed waste.

Radioactive waste is only collected, stored, processed, packaged, shipped, or disposed in accordance with Government regulations. The Radiation Safety Officer (RSO) will assure the preparation and maintenance of procedures for handling radioactive waste that protect the health and safety of all employees involved in such duties as well as members of the general public. All radiation exposures must be As Low As Reasonably Achievable (ALARA). Instructions for segregation and packaging of radioactive waste are based on regulations and appropriate regulatory guidance, and include keeping records to ensure complete tracking and accounting of all material.

## DEFINITIONS

**"Animal Waste"** means animal carcasses or parts which contain radioactive material, including collected excreta and bedding materials, e.g., shavings or sawdust.

**"Aqueous"** means a soluble liquid or a liquid readily dispersible in water, which contains no chemicals classified as toxic or hazardous. Aqueous liquid waste can be discarded to the sewer, unless otherwise limited by the radioactive material content.

**"Compactable Waste"** means any non-putrescible, dry waste, e.g. paper, plastics, glassware, and metals that do not contain compressed gases or liquids, pyrophoric, or other hazardous materials.

**"LS Media"** means any mixture of solvents and/or fluors used for liquid scintillation counting. LS Media must be segregated for disposal, based on the solvents and nuclides they contain:

1. **"NHNT"** refers to nonhazardous, nontoxic, non- flammable solvents.
2. Flammable or toxic solvents, e.g., toluene, xylene, dioxane, pseudocumine, etc. These shall not be used without direct authorization from the RSO.

**"Mixed Waste"** means any waste material containing both radioactive material and a substance listed as a hazardous material by the U.S. Environmental Protection Agency (40 CFR 261).

**"Radioactive Waste Technician"** (Technician) means an individual designated by the RSO who collects, processes, packages, and disposes of radioactive waste.

**"Regulated Medical Waste"** means human tissue or blood, animal waste, sharps, etc., as defined by the Department of Transportation (49 CFR 173, Appendix G).

## REQUIRED TRAINING AND QUALIFICATIONS

All individuals at the University of Utah who use radioactive material are required to attend appropriate training. This training includes instruction on segregating waste, packaging waste, and communicating information about waste. An individual must receive radioactive material training and demonstrate knowledge of the topic before being permitted to use radioactive material, including handling or preparing waste.

A Technician is required to complete 24 hours of classroom instruction in hazardous waste operations and should possess a current Utah Commercial Driver's License with a hazardous waste endorsement. The classroom instruction includes radiation safety principles, specific instruction for operating drum handling equipment, such as a drum truck, pallet truck, pallet stacker, and forklift and includes a demonstration of proper procedures and safety precautions.

## PICKUP REQUESTS AND SCHEDULING

Waste pickup requests are typically initiated by filling out an online form through the Radiological Health Department website. Waste pickups for laboratories that generate significant quantities of wastes may be scheduled to occur on a regular basis. If the Technician cannot meet the scheduled time, they will notify the laboratory and arrange for an alternate time. Requests for waste pickups may also be made by telephone to the Radiological Health Department. Individuals taking telephone requests will notify the Technician by e-mail or telephone.

## PERSONAL PROTECTION EQUIPMENT

Minimum protective clothing required for all individuals participating in the handing of radioactive waste shall include a radiation badge dosimeter, closed-toe shoes, long pants which cover the legs, a lab coat, and disposable protective gloves. Lab coats and gloves should not be worn in public areas on or off the campus, unless directly participating in waste handling procedures. The Technician will not participate in radioactive waste handling or collections unless wearing the personally issued radiation dosimetry badge.

Safety goggles and/or a face shield are to be worn during packaging or disposal of liquid waste. Steel toed safety shoes and canvas or leather gloves shall be worn when moving steel drums, steel storage bins, or other heavy or sharp objects. The RSO must be notified if personal protective equipment is unavailable or if there are any issues or concerns regarding conditions that may require the use of additional protective devices. At no time should radioactive waste pickup or processing occur if personal protective equipment is not worn.

## TRANSPORTATION OF WASTE

Whenever low-specific activity (LSA) radioactive materials are present in a vehicle, it must be posted on all four sides with "RADIOACTVE" placards. Otherwise, switch the placards to the alternate or blank position.

A wheeled cart or drum is used to transport waste packages of all types to the waste transport vehicle. Liquid waste must be in secondary containers while in the vehicle during transportation; the transfer cart or drum may serve as a secondary container. Dry waste and frozen animal waste may be transported in plastic bags or fiberboard boxes. The transfer drum and cart must always be securely anchored within the transport vehicle during transport to prevent movement.

Whenever unattended, the transport vehicle containing radioactive waste must be securely locked. All radioactive materials are removed from the vehicle at the end of each work day. Radioactive waste shall never be stored overnight in a vehicle.

If the vehicle is involved in an accident while transporting radioactive waste, Campus Police (801-585-2677) and the RSO (801-581-6141) are to be immediately notified. The RSO, or assigned designee, will determine if there is any contamination and supervise cleanup as necessary.

## COLLECTION AND ACCEPTANCE OF WASTE

Waste will only be accepted if appropriately segregated, packaged, and identified as specified in RPR 13, "Radioisotope Acquisition and Disposition". Before accepting any waste package, the Technician will ensure that a radioactive waste tag (RPR 13E) has been properly completed. When disposing of mixed waste, laboratory personnel must also attach specific information to enable appropriate disposal of the material. If the mixed hazard type is biological, a complete bioagent description must be included. If the mixed hazard type is chemical, you must include a complete chemical description which indicates the chemical, chemical #, the physical form, the volume/weight, the CAS#, and % of content. Assistance in gathering this information can be obtained by contacting the Department of Environmental Health and Safety. If the Waste is not properly packaged or not accompanied by an appropriately completed waste tag or is mixed waste that does not contain the hazard information, it will not be accepted for pick up. Depending on the immediate circumstances, the Technician may instruct the lab on corrections and wait for them to be completed. This is at the discretion of the Technician's schedule. It may be appropriate to schedule another pickup and have the Technician return another time. In any case, waste not appropriately prepared and identified will not be accepted for pickup.

An appropriate survey meter, calibrated for both contamination and exposure rates, shall accompany the Technician. This survey meter is to be used for checking external surfaces of waste containers for contamination by surveying a wipe (tissue, paper towel, etc.) and for checking that exposure levels are within regulatory limits.

The exposure rate of the material is to be determined before removing it from the waste container. If the measured exposure rate is greater than 100 mrem/hour at 30 cm from the waste, the Technician will contact the RSO for instructions. After each pickup, at minimum, gloves, lab coat, and hands are to be surveyed for contamination. The exposure rate of the transfer drum or cart is to be determined by

direct survey when containing waste from more than one lab to ensure it is below 100 mrem/hour at 30 cm. Contact the RSO for instructions if these rates are exceeded.

**Sharps**

All contaminated sharp objects, e.g., needles, pipettes, razor blades, scalpels, glassware, etc., are accepted only if packaged in heavy duty cardboard boxes or puncture-proof containers specifically made for holding sharps.

**Dry Waste**

The contents are visually examined to ensure that only dry waste is in the container. If the tag indicates that the bag contains only short-lived (half life < 120 days) nuclides, look carefully for non-obliterated stickers, tags, or labels reading "RADIOACTIVE MATERIAL". Carefully remove the bag from the waste container, inspecting for protruding hypodermic needles, pipettes, or other sharp objects that may cause the bag to rupture. Watch for leaks and perform a survey of any leakage to determine the presence of radioactive contamination. Ensure the dry waste does not contain any visible liquid or liquid scintillation vials.

If there are indications of inappropriate items in dry waste, immediately inform lab personnel. Do not accept any waste packaged in bags which cannot be visually inspected. If the problem can be corrected without risk of personal contamination, ask lab personnel to correct the problem before accepting the waste. If there is risk of personal contamination, the waste is placed into a secondary bag and accepted; however, the issue is noted on the "Generator" copy of the waste tag and lab personnel are informed. Lab personnel should be told that waste with similar problems will not be accepted in the future. In any case, the RSO is to be notified each time.

The bag containing dry waste must be securely closed and placed in the transfer drum or cart. A new clear vinyl bag is appropriately placed in the waste container and the lid replaced.

**Bulk Liquid Waste**

Individual containers for liquid waste collection should never exceed a capacity of 2.5 gallons unless specifically approved for exemption by the RSO. Each bulk liquid container is placed into a secondary container which has a volume capacity at least equal to the volume container of the bottle. The purpose of the secondary container is to hold the full volume of waste in cases where the primary container fails.

The Technician will carefully lift the container to inspect for leakage or the presence of solid material. If leaking or solid material is observed, the Technician should put the container back into the secondary container and inform lab personnel that the problem must be corrected before the waste pickup is completed.

The container is secured with the appropriate waste tag tied or taped to it and then placed in the transfer drum or cart. An empty waste container is then placed into the secondary container.

**Liquid Scintillation Vials**

Liquid scintillation vials (LSC) may be readied for pickup and transported in bulk plastic bags or, preferably, their original cardboard trays.

The Technician verifies that vials are properly segregated and labeled according to the nuclides and fluors present. Each package is carefully examined for leakage. Vials in trays are placed into a bag before placing them in the transfer drum or cart.

**Animal Waste**

All animal waste must be frozen. The Technician will only accept animal waste when each frozen package weighs less than 10 kg (~22 lbs). Procedures are the same as dry waste except that the Technician assures that frozen animals are not allowed to thaw.

An exception in 10 CFR 20.2005 allows for disposal of 50 nCi, or less, of H-3 or C-14 per gram of animal tissue, averaged over the weight of the entire animal, as if it were not radioactive. An effort should be made to contact those research labs who use H-3 and C-14 on animals, to help them segregate waste that meets this disposal criteria. These labs are asked to segregate animals from their bedding, waste, and other materials. Further, these labs will be asked to carefully track the mass of, and radionuclide activity in, each animal carcass. This particular animal waste is to be collected and handled by the Technician as other animal waste (frozen and less than 10 kg per package) but must be carefully checked for proper segregation and information collection. If the animal meets the criteria in 10 CFR 20.2005, then it can be disposed of as if it were not radioactive.

**Lead Containers and Shielding**

Non-contaminated pieces of lead, e.g., shields, bricks, containers, etc., are not to be treated as radioactive waste. No waste tag is necessary. The Technician will pick them up separately to be stored or salvaged. Contaminated lead is to be treated as a mixed waste hazard.

## RECORDS

No package of radioactive waste is to be disposed of in any manner unless appropriate information is entered into the database. Database entry is performed by one individual, typically the Technician, and a verification of the entry data is performed by another individual, typically a health physicist.

When removing waste from a location, the Technician dates and initials the waste tag (RPR 13E) and leaves the "Generator" copy with laboratory personnel. All other copies of the waste tag accompany the waste to the waste processing facility.

At the time of processing, the container identification number and processing date are entered on the waste tag. Personnel performing the processing initial the waste tag and removes the "Radiological Health" copy. This copy is used to enter updated information into the database. Prior to release of waste packages that have been stored for decay, the package is surveyed and the exposure rate entered on the waste tag and initialed. When waste is packaged into a drum for offsite disposal, the "Container"

copy of the waste tag remains with the package. When liquids or solids are released, the "Container" copy of the waste tag is removed and disposed.

## SEGREGATION, PACKAGING, AND DISPOSAL OF RADIOACTIVE WASTE

### Short-lived Dry Waste

Waste that contains only short-lived ($T_{1/2}$ < 120 days) radionuclides should not contain any labels, stickers, or markings indicating the presence of radioactive material. This waste material is weighed and the weight is recorded on the waste tag. If possible, this material is further segregated by half life into storage bins to be held for decay in storage. The following table provides guidelines for minimum storage times.

**"Minimum Storage Time"**

| Half Life | Example Nuclides | Minimum Storage Time |
|---|---|---|
| < 3 days | Ga-67, Mo-99, Tl-201, In-111, Au-198, Pb-203, Hg-195m, Tc-99m, Na-24, I-123 | 1 month |
| < 15 days | P-32, I-131 | 5 months |
| < 60 days | I-125, Hg-203, Fe-59, Ru-103, Nb-95, Cr-51, P-33, Rb-86 | 20 months |
| < 90 days | S-35, Sc-46, Ir-192, Sr-85, | 30 months |
| < 120 days | Sn-113 | 40 months |

Table RPR54.1 "Minimum Storage Time"

Monthly, the database is used to prepare a list which identifies packages that have been held in storage for at least the minimum time period. When sufficient packages are listed, the packages are retrieved from storage and surveyed. The maximum count or exposure rate from a package must be indistinguishable from background when surveyed with a survey instrument set to the greatest sensitivity. The measured exposure rate is recorded on the waste tag and the package disposed as not radioactive waste. Prior to disposing of decayed waste, the "Container" copy of the waste tag is dated, initialed, and removed. This copy is kept by the Radiological Health Department. It is very important to keep in mind that radiation may not be the only hazard to be considered. Once the radioactive component is allowed to decay, the waste is treated considering other hazards. For example, waste may be infectious, biohazard, or medical waste and must be treated by the appropriate regulatory authority. Regulated medical waste is disposed of through the infectious waste section of the county landfill. An "Infectious Substance" label is attached to each sharps container. If a University vehicle is used to transport infectious waste to the landfill, the vehicle must be placarded with the "Dangerous" placard.

### Long-lived Dry Waste Compaction

Waste consisting of long-lived (> 120 days) radionuclides and containing only dry solid waste is gathered for compaction. An individual removes the "Radiological Health" copy of the waste tag

and enters the data into the database. All long-lived waste packages are inspected for prohibited items before placement into the compactor.

The maximum activity that can be placed into a single 55-gallon (208.2 X $10^{-3}$ $m^3$) drum is limited by the more restrictive value of either the Class A waste limits found in 10 CFR 61.55 or the license of the waste receiver. The following table contains class A limits from 10 CFR 61.55:

**"Class A Concentration Limits"**

| Radionuclide | Class A Limit Concentration | Limit for 55 gallon drum [mCi] |
|---|---|---|
| C-14* | 0.8 [Ci/$m^3$] | 166.56 |
| Cm-242† | 2000 [nCi/gram]† | by mass not volume† |
| Co-60 | 700 [Ci/$m^3$] | 145738 |
| Cs-137 | 1.0 [Ci/$m^3$] | 208.20 |
| H-3 | 40 [Ci/$m^3$] | 8328 |
| I-129 | 0.008 [Ci/$m^3$] | 1.67 |
| Nb-94** | 0.02 [Ci/$m^3$] | 4.16 |
| Ni-59** | 22 [Ci/$m^3$] | 4580 |
| Ni-63* | 3.5 [Ci/$m^3$] | 728.69 |
| Pu-241† | 350 [nCi/gram]† | by mass not volume† |
| Sr-90 | 0.04 [Ci/$m^3$] | 8.33 |
| Tc-99 | 0.3 [Ci/$m^3$] | 62.46 |
| Total of all nuclides with half-life < 5 years | 700 [Ci/$m^3$] | 145738 |
| Alpha emitting transuranic with half-life > 5 years† | 10 [nCi/gram]† | by mass not volume† |

Table RPR54.2 "Class A Concentration Limits"

*Increase table limit by a factor of 10 if radionuclide is in activated metal form.

**Table limit is applicable only if radionuclide is in activated metal form.

†Class A concentration limits for these radionuclides are in units of Activity per Mass. Note that 1 [nCi/gram] is equivalent to ~454 [nCi/lb].

For waste containing a mix of nuclides listed in table RPR54.2, the limit for Class A waste is determined by a "sum of fractions" rule. The percentage fraction of the different nuclides, as compared with their limit, is summed. To maintain Class A status, the sum of the fractions must be equal to or less than 100%.

**Compactor Use**

The "two-man" rule is a requirement for compaction work. Leather gloves are required for any compactor maintenance/repair work or when moving drums into or out of the compactor. When compacting, DOT Specification 17C (or equivalent) drums that are new or in excellent condition must be used. The drum is then placed into the compactor and the exhaust fan is turned on. Dry waste packages are placed into the drum along with the "Container" copy of the waste tag. Compaction is performed in accordance with the manufacturer's instructions and repeated until the drum is full. Maximum compaction capacity is obtained by periodically

leaving the compaction ram in the fully down position in order to reduce "spring-back" of the compacted waste. Full drums are to be sealed and secured with the lid lock ring. Instructions on closing and sealing drums are posted at the waste processing facility. Each drum is to be weighed and surveyed and prepared for transportation in accordance with procedures in RPR 55 "Transportation of Radioactive Materials."

**Liquid Scintillation Vials**

Only liquid scintillation vials, which are NHNT, are accepted for disposal without further segregation of the components. Waste generated by laboratories that contain hazardous or toxic liquid scintillation vials should empty and rinse each vial into a bulk liquid waste container for appropriate disposal. Empty vials are disposed as dry waste only if they contain no hazardous constituents. Vials containing > 50 nCi/gram of H-3 or C-14 are collected in 55 gallon drums for disposal. Vials containing < 50 nCi/gram of H-3 or C-14 are considered non-radioactive and are transferred to Environmental Health and Safety for disposal.

**Bulk Aqueous Liquid Waste**

Aqueous liquid waste in bulk containers is collected and stored near the disposal sink until the waste tag data is entered and verified. Liquid waste is then typically discarded into the sanitary sewer system as allowed by regulation. Before each disposal, the activity of all radionuclides to be discarded is determined. This activity is compared to the cumulative previous monthly and annual disposals. If the quantity to be disposed is allowable by regulation and/or license conditions, the disposal process can proceed. Aqueous liquid waste containing radioiodine or transuranic nuclides is segregated for storage and held for decay. All other liquid waste is segregated for packaging.

**Bulk Liquid Mixed Waste**

When disposing of mixed waste, laboratory personnel must also attach specific information to enable appropriate disposal of the material. If the mixed hazard type is biological, a complete bioagent description must be included. If the mixed hazard type is chemical, you must include a complete chemical description which indicates the chemical, chemical #, the physical form, the volume/weight, the CAS#, and % of content. Assistance in gathering this information can be obtained by contacting the Department of Environmental Health and Safety. The container is weighed, the weight entered on the waste tag, and the waste then placed into a flammable liquid storage cabinet. The data is entered into the database and verified. Any waste product containing only H-3 and/or C-14 in concentrations < 50 nCi/gram is disposed of as non-radioactive hazardous waste. Any material transferred to another entity as non-radioactive waste must always be checked for the presence of labels, stickers, and markings indicating radioactive material. These labels, stickers, or markings shall be obliterated.

Mixed waste liquids are packaged as a limited quantity or LSA waste as defined by the Department of Transportation (DOT). A specification 17C steel drum is used. Place a 4-mil plastic liner in the drum. Add 4-6 inches of absorbent material, e.g., Ultrasorb 248TM. Place a second plastic liner inside the first liner, and then place the liquid containers, right side up,

within the second liner. Add enough absorbent material to completely absorb two times the actual volume of liquid contained in the drum. Typically, a 55 gallon drum will hold 15-16 gallons of liquid in 1-gallon jugs, with all interstices filled with absorbent. Both liners are tightly closed, the drum lid attached and sealed in accordance with the posted instructions. Each drum is to be weighed and surveyed and prepared for transportation in accordance with procedures in RPR 55 "Transportation of Radioactive Materials."

A shipment of mixed waste bulk liquids must be preapproved by a receiving facility. Shipments of mixed waste are scheduled to ensure that no package of mixed waste is held for more than 90 days.

**Animal Waste**

Each package of animal waste is weighed upon receipt and placed in a freezer for storage. Waste tag information is entered and verified in the database. Animal waste containing < 50 nCi/gram of H-3 and/or C-14 is to be treated as non-radioactive and transferred to the appropriate department for disposal. Animal waste containing short-lived nuclides are stored for radioactive decay. Animal waste containing long-lived nuclides are prepared for disposal.

## STORAGE OF PACKAGED RADIOACTIVE WASTE

Drums in storage awaiting shipment for disposal are to be marked with all appropriate labels and markings required for shipment of radioactive material. A Radioactive Waste Container Data form is to be completed for every container (drum) of radioactive waste at the time it is packaged. The container data is promptly entered into the database. Sealed drums should be placed on wooden pallets for convenient forklift transfer. Waste shipments should be scheduled at a frequency to prevent excessive accumulation of filled drums.

## ANNUAL DATA SUMMARIES

Summaries of all radioactive waste disposals are generated annually from the Radiological Health Department database. Summaries are filed with the annual reports prepared for the records of the Radiation Safety Committee. The database is used to summarize information required for waste shipment manifests, as described in RPR 55 "Transportation of Radioactive Materials".

## REFERENCES

U.S. Nuclear Regulatory Commission: 10 CFR 20.301-311 and 10 CFR 61; 10 CFR 71

State of Utah Department of Environmental Quality, Division of Radiation Control, Utah Radiation Control Rules (R313)

Utah Radioactive Material License UT1800001