

8.0 Radioactive Waste

8.1 Solid Radioactive Waste Management

Solid radioactive waste is disposed of by land burial at licensed, low-level radioactive waste facilities or by holding short-lived wastes for radioactive decay until their radiation levels are indistinguishable from background, and then disposing of them as ordinary waste. Because the availability of land burial sites is subject to political and technical limitations, and the space available for decaying short-lived wastes is limited, radioisotope users should make every effort to minimize the volume of radioactive wastes generated in their laboratories.

All solid radioactive waste is packaged by users and then transferred to DRS personnel for treatment by decay-in-storage or other method of final disposal.

As much as possible, wastes must be segregated according to isotopes. It is especially important to segregate dry wastes containing tritium (H-3) and carbon-14 (C-14) from other long-lived isotopes.

Solid wastes should be collected, stored, and packaged in containers lined with plastic bags with a thickness of at least four mils of LDPE, clear or transparent yellow in color, and bearing the radiation hazard symbol. The containers must be labeled with the radiation hazard symbol and the words "*Caution–Radioactive Material*". Individual bags should be no greater than 30 gallons in volume. Laboratories are responsible for providing their own disposal containers and bags.

No freestanding liquids, lead, sharps or animal carcasses/tissue shall be disposed of in solid wastes. If lead cannot be decontaminated, it should be packaged separately for collection. See section 8.3 for handling of radioactive sharps.

MIXED WASTE CAUTION: Activities that generate wastes that are classified as both hazardous chemical wastes and radioactive wastes require special handling and incur high disposal costs. *Mixed waste generation should be minimized to the extent practical.* More information is provided in section 8.7 to follow.

It is the responsibility of the laboratory personnel to comply with segregation, collection, packaging, and labeling requirements and to secure all wastes for removal from the laboratory. DRS will not handle any package that does not conform to the requirements of this section or which, in their opinion, may present a safety hazard to waste-handling personnel or members of the public. Containers/packages of waste that are not properly packaged and labeled must be promptly corrected.

Prior to pick-up by DRS, each container must have a completed *Radioactive Waste* tag attached to it. These tags are available from DRS. Appendix B gives instructions for completing these tags. When waste has been properly prepared, log on to DRS website at: <http://www.drs.illinois.edu/radiationsafetyapp/Waste/PickupRequest.aspx/> and complete the online pickup request.

8.2 Liquid Scintillation Counting Vials, Glassware, and Plastic Containers

Empty liquid scintillation counting vials that contained media with a concentration of C-14 or H-3 less than 0.05 micro-Curie per milliliter ($\mu\text{Ci/ml}$) need not be decontaminated and should be disposed of with the regular, non-radioactive solid waste. Ensure that vials have been properly emptied and “radioactive material” labels have been removed or defaced.

Used vials may be decontaminated by washing; alternatively, emptying and then discarding into the appropriate radioactive waste container is acceptable. Segregate wastes by radionuclide half-life (≤ 120 days and > 120 days).

Most glass items (e.g., test tubes, dishes) can be decontaminated by routine washing or an overnight soaking with an industrial-strength detergent and re-used.

8.3 Radioactive Sharps

Radioactive sharps are hazardous items that require special precautions and handling. If the following items have come into contact with radioisotopes, dispose of them in containers specifically designed for sharps that bear a *Caution–Radioactive Material* label listing isotope and date:

- Needles and syringes,
- Pasteur pipettes,
- Scalpels and razor blades,
- Microscope slides and coverslips,
- Glassware that cannot be decontaminated.

Sharps containers are closable, puncture-resistant, leak-proof on the sides and bottoms, and are typically available in 1-quart, 2-gallon, and 8-gallon sizes.

Most glassware, such as liquid scintillation vials and test tubes, is easily decontaminated as described in section 8.2 and should not be routinely discarded as sharps.

When sharps containers are full and properly tagged, enter the appropriate information for pickup and disposal on DRS website at <http://www.drs.illinois.edu/>.

8.4 Liquid Waste

There are two main types of liquid radioactive wastes generated by research laboratories. The most common liquid waste is aqueous, in which the waste materials are dissolved in water. Such waste may be disposed of by dispersal into the sewage system if concentration limits are low enough. Designate and label a sink for this purpose. The pH range of any aqueous waste shall be adjusted to between 6.8 and 8.0. Aqueous wastes shall not exceed the following concentrations:

<u>Radionuclide</u>	<u>Concentration ($\mu\text{Ci/ml}$)</u>
H-3	1×10^{-2}
C-14	3×10^{-4}
P-32	9×10^{-5}
P-33	8×10^{-4}
S-35	1×10^{-3}
I-125	2×10^{-5}
I-131	1×10^{-5}

Other radionuclide concentration limits can be found in Title 10, Code of Federal Regulations, Part 20, Appendix B, Table 3.

The other, less common form of liquid radioactive waste is composed of volatile, flammable, toxic or organic material that cannot be disposed of through the sewage system. Water insoluble organic solvents shall not be released into the sewage system under any circumstances. (Toluene and xylene-based liquid scintillation cocktails and some HPLC fluids fall into this category. Users are advised to use water-soluble fluids whenever possible). *Non-aqueous waste shall be free of all filterable solids.* For filtering liquid scintillation waste, a 60-mesh metal screen is recommended. Organic, water-insoluble liquid waste is then collected by DRS personnel for disposal. Non-aqueous waste shall be stored in spill-proof, unbreakable plastic containers of either six or ten liter capacities.

Liquid wastes that do not fit into the above categories must be treated on a case-by-case basis. See also Section 8.7 *Mixed Wastes*

CAUTION:

Problems involving chemical reactions between mixtures of liquid wastes may occur. Disposing of cyanides in acidic liquid waste will produce hydrogen cyanide, a very toxic gas. Special care must be taken when disposing of tissue that has been digested in nitric acid, as oxides of nitrogen may be formed that could cause the waste container to explode. The PI must ensure that chemical reactions will not occur in liquid waste containers.

Improperly prepared or packaged radioactive waste that during movement or handling will pose an unacceptable hazard to workers, other members of the campus community, or the public must be immediately corrected before pick-up by DRS personnel can occur. Improperly packaged radioactive waste must not be left uncorrected.

Prior to pick-up by DRS, each container must have a completed *Radioactive Waste* tag attached to it. These tags are available from DRS. Appendix B gives instructions for completing these tags. When waste has been properly prepared, logon to DRS website at: <http://www.drs.illinois.edu/> and complete the online pickup request.

8.5 Animal Carcasses

Radioactive material used in animals must be handled on a case-by-case basis. PIs planning to administer radioactive material to animals should contact DRS for guidance concerning the disposal of carcasses.

Animal tissues containing 0.05 μCi or less of H-3, C-14, or I-125 per gram of animal tissue averaged over the weight of the entire animal can be disposed of as if it were not radioactive. However, animal tissue in which radioactive materials have been introduced *shall not* be disposed in a manner that would permit its use either as food for humans or as animal feed, such as rendering.

8.6 Unacceptable Methods of Radioactive Waste Disposal

No freestanding liquids, lead, sharps, or animal carcasses/tissue may be disposed of in solid wastes.

Under no circumstances shall personnel bury radioactive waste in the soil.

Under no circumstances shall *non-aqueous* radioactive waste be released into the sewage system.

Aqueous radioactive liquids in excess of the concentrations specified in Section 8.4 shall not be released into the sewage system. The liquid must either be held for decay or turned into dry waste and packaged appropriately.

Carcasses or animal tissues in which radioactive materials have been introduced *shall not* be disposed of by rendering (a manner that would permit its use either as food for humans or as animal feed).

8.7 Mixed Wastes

Mixed wastes are defined as wastes that contain radioactive materials and a hazardous waste. These types of wastes require special handling. Researchers are encouraged to minimize the generation of mixed wastes because of the high disposal costs.

For example, radioactive wastes that contain any of the following must be handled as a mixed waste (this list is not exhaustive, be alert for additional hazardous components that may be in your waste):

Solvents (e.g., methanol, methylene chloride, acetone)	Carbon Tetrachloride
Flammable chemicals	Chlordane
Nitrates	Chlorobenzene
Sulfides	Chloroform
Cyanides	O-Cresol
Aqueous solutions with pH ≤ 2 or $\geq 12.5^*$	M-Cresol
Arsenic	P-Cresol
Barium	1,4-Dichlorobenzene
Cadmium	1,1,-Dichloroethylene
Chromium	2,4-Dinitrotoluene
Lead	Heptachlor
Mercury	Hexachlorobenzene
Selenium	Hexachlorobutadiene
Silver	Hexachloroethane
Endrin	Methyl Ethyl Ketone
Lindane	Nitrobenzene
Methoxychlor	PCBs
Toxaphene	Pentachlorophenol
2,4-D	Pyridine
2,4,5 TP (Silvex)	Tetrachloroethylene
Benzene	Trichloroethylene
*If pH is the only item on this list that makes the item a mixed waste, it can be neutralized and handled as Rad Waste.	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol
	Vinyl Chloride

If the waste contains I-125, P-32, P-33, S-35, Fe-59, or other short half-life (<90 days) radioisotopes in addition to anything listed above, the waste should be retained by the generator until it is adequately decayed (typically 10 half-lives) so that it no longer qualifies as a regulated radioactive waste. The waste can then be classified as chemical waste and a chemical waste pick-up can be initiated at: <https://www.dr.illinois.edu/chemicalwastepickup>

Remember to ensure that shielding (as needed) and proper containment is in place in the laboratory during the time the waste is retained in the laboratory while decaying.

If the waste contains C-14 or H-3 isotopes in addition to anything listed above, the following procedures should be followed:

8.8 Radioactive Mixed Waste - Generator Responsibilities

1. Initiate a chemical/mixed waste request at:
<https://www.drs.illinois.edu/chemicalwastepickup>
2. A copy from the liquid scintillation printout for the particular waste should be submitted to the DRS personnel picking up the waste. A calculation of the isotopic concentration (in $\mu\text{Ci}/\text{ml}$) and total activity (μCi) for the waste is required. If there are multiple wastes, a copy of the printout with calculations should be submitted for each waste.

DRS personnel are responsible for the pickup and disposal of mixed wastes from campus laboratories.

Appendix A: Responsibilities for Radiation Safety

The U of I strives to maintain a safe and healthy working and learning environment for faculty, staff, students, and visitors. The cooperation of the entire campus community is needed to realize this goal. This is particularly true of research and teaching that involves radiation sources, where the Campus Radiation and Laser Safety Committee, and radiation safety officer (RSO), principal investigators (PIs) and department heads, and laboratory workers share the responsibility for creating and maintaining a safe workplace.

Radiation and Laser Safety Committee Responsibilities

The Radiation and Laser Safety Committee advises the Chancellor through the Vice Chancellor for Research and the Division of Research Safety (DRS) on matters related to the campus Radiation Safety Program. The Committee is composed of academic staff and faculty members representing various areas of research and teaching, and members who represent the campus administration including the campus RSO.

The chancellor delegates authority to the committee to oversee the use of radiation sources throughout the campus. The committee has the authority to permit, deny, or revoke authorization for individuals to obtain and use radiation sources at the University of Illinois at Urbana-Champaign.

The responsibilities of the Radiation and Laser Safety Committee include the following:

1. Review proposals for unusually hazardous uses of radiation sources as deemed by the RSO, and establish criteria for equipment and procedures to ensure employee, student, and public safety.
2. Review cases that involve repeated infractions of the rules and regulations for protection against radiation, including lasers.
3. Review accidents that may involve exposure or serious economic loss and other cases for which reports to outside regulatory authorities are required.
4. Review public relation problems that involve radiation sources and lasers.
5. Review appeals from radiation users and modify rules or the decisions of DRS personnel where necessary.
6. Meet formally as often as necessary, but at least four times per year, to review the campus radiation safety program with DRS personnel.
7. Recommend the establishment or modification of campus radiation and laser safety policies.
8. Work with DRS to effectively use electronic communication to keep committee members abreast of unusual events between committee meetings.
9. Review communications between DRS and government agencies that affect the campus radiation safety program and the campus radioactive materials license.

Division of Research Safety and Radiation Safety Officer Responsibilities

1. Provide advice and assistance to all concerned on all aspects of radiation safety.
2. Approve proposals for procurement, use and transfer of radiation sources except proposals involving unfamiliar or extreme hazards that DRS judges as requiring review by the Committee.
3. Receive and monitor all shipments of radioactive materials, deliver acceptable incoming shipments to the consignee, and ensure that outgoing shipments conform to shipping regulations.
4. Maintain permanent records of receipt, use, transfer, and disposal of radioactive materials.
5. Supervise and assist in disposal of radioactive wastes.

6. Assign personnel monitoring devices (e.g., film badges, dosimeters) when necessary, give instructions in their use, and maintain personnel monitoring records.
7. Check radiation monitoring and survey instruments for proper operation and calibrate as often as necessary.
8. Assist in designing and selecting equipment, shielding, and facilities and in the formulating operating procedures for new or modifying existing installations or buildings.
9. Calculate the levels of radiation intensity, time limits of personnel exposure, and minimum working distance around accelerators, reactors, X-ray machines, and other intense radiation sources.
10. Perform and keep records of leak tests on sealed sources.
11. Make and keep records of systematic surveys in areas where the presence of radiation or contamination of surfaces, air, or water is suspected, and notify the area supervisor of the results. In some cases this may require detailed monitoring of an operation from beginning to end by a DRS member.
12. Report hazardous radiological conditions promptly to the individual responsible and, when necessary, to the immediate supervisor and the Radiation and Laser Safety Committee.
13. Supervise and assist in decontamination of all but minor spills.
14. Schedule routine medical examinations in accordance with established policy; help establish criteria, and make arrangements for such examinations as may be required in emergency situations.
15. Enforce all written directives of the committee.
16. Stop any operation or deny access of any individual to radiation sources in the interest of safety. Such action must be reported verbally and in writing to the committee as soon as possible.
17. Grant exemptions to the rules (or impose more stringent restrictions) in emergency situations when, in the judgment of DRS, such action is necessary to reduce risk of serious injury or economic loss. Such actions must be reported verbally and in writing to the committee as soon as possible.
18. Maintain files of federal, state, and local licenses and registrations concerned with radiation sources and initiate applications for renewals and/or amendments of same.
19. Determine whether a radiation incident requires a report to any governing body and prepare such reports for the approval of the committee. Exception: If an immediate report is

required, the campus radiation safety officer shall (with knowledge and approval of the chairman if possible) file such report with the appropriate authorities and shall provide copies to the committee.

20. Be familiar with the federal, state, and local laws relating to radiation and be aware of changes in such laws as they occur. Inform the committee when such changes make modifications of policy desirable and institute necessary changes in the radiation safety program.