Proper Segregation and Disposal of Low-Level Radioactive Waste Procedures Manual

Revision: April 9, 2026

Applies To: University of Michigan (U-M) personnel preparing low-level radioactive waste for collection.

Table of Contents

Table of Acceptable Segregation Categories for Low-Level Radioactive Waste

Use a separate container for each category. In some instances, Environment, Health & Safety (EHS) may require further segregation as necessary for safe handling.

- **Long Lived Isotopes (> 90 days Half-Life)**
  - Category A - H-3 and/or C-14
  - Category B - Na-22, Cl-36, Ca-45, Co-57, Co-58, Fe-59, Co-60, Ni-63, Sr-90, Tc-99, Sn-113, and/or Cs-137, etc. (excluding H-3 and C-14)
- **Intermediate-Lived Isotopes (> 14 days - Less than or equal to 90 days half-life)**
  - Category C - S-35, P-33, Sc-46, Cr-51, Sr-85, Rb-86, Ru-103, and/or Ce-141, etc.
  - Category D - I-125, P-33, Sc-46, Cr-51, Sr-85, Rb-86, Ru-103, and/or Ce-141, etc.
- **Short-Lived Isotopes (< 14 Days half-life)**
  - Category E - P-32, C-11, F-18, Na-24, Br-82, Y-90, Nb-95, Tc-99m, In-111, I131, and/or Tl-201, etc.

Preparing Solid Low-Level Radioactive Waste for Collection

Solid low-level radioactive waste (LLRW) **must** be prepared for collection. Solid LLRW cannot be discarded as normal trash. Solid LLRW includes dry contaminated laboratory materials, equipment, and supplies such as:

- Paper and absorbent pads
- Unbroken glass
- Plastic products
- Contaminated (and potentially contaminated) personal protective equipment (gloves, shoe covers, etc.)

Do not use this procedure if this waste stream is:

- Non-LLRW (paper towels, boxes, etc.); follow the procedure Disposing of Uncontaminated Waste that Will Not Puncture the Skin.
- Liquid LLRW; follow the procedure Preparing Liquid Low-Level Radioactive Waste for Collection.
- Liquid scintillation vials (empty or full); follow the procedure Preparing Liquid Scintillation Vials for Collection.
- Sharps; follow the procedure Preparing Sharps Low-Level Radioactive Waste for Collection.
- Stock vials; follow the procedure Preparing Stock Vials for Collection.
- Animal carcasses, blood, tissue, organs, urine, feces, and bedding; follow the procedure Preparing Animal Carcasses and Animal Tissues Contaminated with Radioactive Material for Collection.
- Lead-shielded containers ("pigs") and leaded objects; follow the procedure Preparing Lead- and Barium-Impregnated Pigs and Objects Impregnated with Lead or Barium for Collection.
- Large contaminated metal objects; request a special collection.

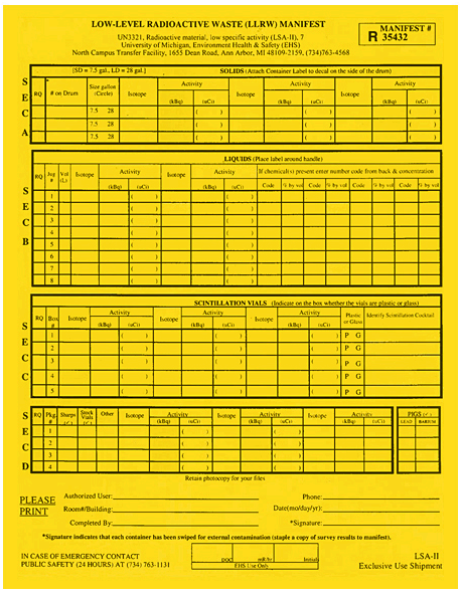
Supplies Available through Hazardous Materials Management

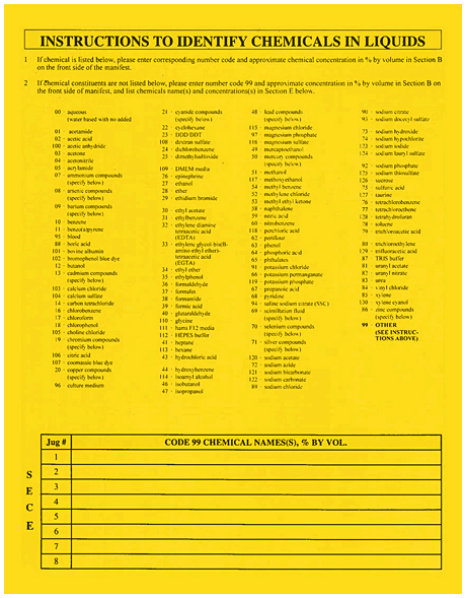
Hazardous Materials Management (HMM) provides the following supplies. To order these supplies, complete the online Supplies Request Form or call (734) 763-4568.

- Small (7.5 gallons) yellow fiber drums lined with a bag
- Large (28 gallons) yellow fiber drums lined with a bag

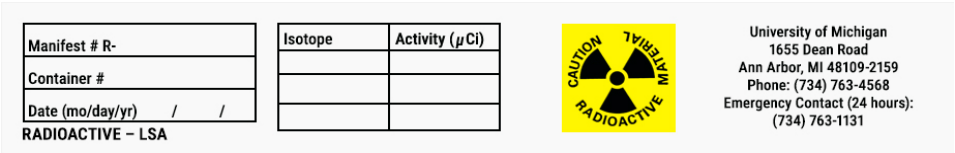
NOTE: EHS reuses the drums, so please refrain from writing or defacing the outside of them.

- LLRW Manifest





- Radioactive Waste Label



Using the Waste Container

1. Ensure the HMM supplied bag liner is installed properly in the drum prior to use.
2. Segregate solid LLRW by isotopes(s).
3. Place solid LLRW into the solid waste drum.
4. Do **not** put any items containing liquids or unused stocks, any pathological waste, or any liquid scintillation vials in the drum.

Procedure: Preparing Solid LLRW for Collection

1. On the manifest, complete Section A and the Authorized User and location information (see “Completing the LLRW Manifest” below).
2. Conduct a removable radioactive contamination survey of the following areas of the solid waste drum:
   - Lid
   - Sides
   - Bottom
3. Is there evidence of removable radioactive contamination?
   - If YES, decontaminate (clean) the outside of the drum and repeat step 5.
   - If NO, go to the next step.
4. Make a copy of the manifest and radioactive contamination survey results for your records.
5. Staple a copy of the radioactive contamination survey results to the manifest.
6. Complete the container label and place at the Place Container Label Here location.
7. Place the manifest in a location where it is visible for collection and where it will **not** become contaminated.
8. Request a waste collection from HMM using one of the following methods:

- Call HMM at (734) 763-4568
- Complete the EHS Supplies Request Form or the EHS Waste Pickup Request form. You can also call (734) 763-4568.

Preparing Liquid Low-Level Radioactive Waste for Collection

This procedure discusses how to:

- Keep the volume of liquid LLRW generated as low as possible;
- Manage liquid LLRW during research; and
- Prepare liquid LLRW for HMM for collection.

Minimizing and Segregating Waste

Minimizing and segregating radioactive liquid waste prior to collection enhances safety and compliance, protects the environment, and reduces the costs to the University from the research and clinical use of radionuclides.

Mixed Waste

Mixed waste is any waste stream containing LLRW commingled in any manner (solutions, mixtures, alloys) with non-radioactive Environmental Protection Agency (EPA)-restricted chemicals or materials. Mixed waste is expensive and, in some rare cases, impossible to dispose of legally and safely.

NOTE: Contact EHS before generating possible mixed waste to obtain approvals, advice, and handling instructions.

Generating Mixed Waste

The EPA and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) restrict the disposal of many chemicals, metals, and other materials based on properties of reactivity, flammability, corrosivity, or toxicity.

HMM can help you determine if the chemicals you are using with radioactive materials are restricted and will result in mixed waste.

Examples of Chemicals Requiring Separate, Segregated Collection Containers

Waste processors are required to use special and additional handling and disposal methods for restricted chemicals, resulting in substantially higher costs to the University. Minimizing and segregating these wastes promotes safe, compliant disposal, and reduces costs. The following table provides examples of chemicals that may require a separate, segregated collection container from other liquid LLRW.

NOTE: Consult with HMM when using chemicals listed below, or those with similar chemical properties.

- Organic Solvents
  - Ethanol
  - Methanol
  - Butanol
  - Acetonitrile
  - Toluene
  - Acetone
  - Ether
  - Ethyl acetate
  - Isopropanol
  - Xylene
- Halogenated Compounds
  - Methylene Chloride
  - Chloroform
- Toxic Compounds
  - Phenol
  - Compounds of heavy metals such as:
    - Arsenic
    - Barium
    - Cadmium
    - Chromium
    - Lead
    - Mercury
    - Selenium
- Strong Acids
  - Hydrochloric acid
  - Phosphoric acid
  - Trichloroacetic acid
  - Any acid that will lower the pH to 2 or less
- Strong Bases
  - Sodium hydroxide
  - Other hydroxides and amine compounds
  - Any base that will raise the pH to 12.5 or above

Minimization and Segregation

To reduce, or minimize, the amount of liquid LLRW generated:

- Do **not** commingle non-LLRW with LLRW in the same waste container as a means of waste disposal.
- Use experimental protocols that isolate restricted chemicals from radioactive material unless necessary and approved by EHS.
- If approved to use restricted chemicals with radioactive material, you **must** minimize the volume of mixed waste generated. Use only the amount of agents needed to perform the experiment and follow any special instructions from EHS.
- Do not combine mixed waste with non-mixed waste. “After-use mixing” of mixed and non-mixed waste renders the entire contents into a mixed waste and may make disposal of the contents extremely expensive.
- Never combine chemically incompatible waste; there is a risk of violent or toxic reaction. Refer to the Chemical Hygiene Plan, section 5.3 (for storage information go to pages 46-48; for chemical compatibility charts go to pages 48-50). You may also contact EHS if you are not sure about chemical compatibility.

Biological, Toxic, or Carcinogenic LLRW

Ensure biological (blood and urine), toxic, or carcinogenic liquid LLRW are rendered innocuous (i.e., bleach, Lysol detergent, other methods), non-toxic, or otherwise neutralized prior to HMM collection.

NOTE: Special handling instructions or precautions should be given to HMM personnel when requesting waste collections containing biological, toxic, or carcinogenic material.

Volatility Controls: Radioiodines, Sulfur-35 Amino Acids, and Other Volatiles

- Unbound radioiodines (e.g., inorganic forms such as sodium iodide [NaI] or metabolized radioiodines in biological waste) are volatile. Acidity or oxidation enhances the volatile nature of these radiocompounds. **NOTE**: Do not add acids or strong oxidizers (e.g., bleach) to waste containing unbound radioiodines.
- S-35 labeled amino acids (methionine and cysteine) have a propensity to radiolyse and release volatile products. Increased activity in the solution enhances this effect. Millicurie amounts collected in waste containers can accumulate volatile forms of S-35.
- A radiocompound has the same chemical properties as its equivalent unlabeled form including volatility. Contact RSS for approval and instructions before acquiring and using any volatile radiolabeled compound.

Volatility Controls for Liquid LLRW Containers:

- Add about 500 mL of a 0.1 M sodium thiosulfate solution to 4-liter waste jugs before adding radioiodine waste to the jug.
- Always make sure waste containers holding volatile radiocompounds are capped when in storage.
- Only uncap waste containers and fill them in an operating, EHS-certified exhaust hood (> 100 lfm).

Collecting Labware Rinses and Washes

1. When washing reusable, radioactively contaminated lab equipment, collect and pour wash and rinse water from the first and second rinse into a liquid LLRWjug.
2. After the third wash and rinse, analyze a 1-mL sample using a liquid scintillation counter sample of the rinse water and compare it to a 1-mL background sample of tap water. Is the count rate < 3 times background?
   - If YES, discard the rinse water down the sanitary drain (sink).
   - If NO, discard the rinse water into a liquid LLRW jug. Repeat this rinse/count process until the count rate for the rinse water is < 3 times background.

What NOT to Place in Waste Jugs

The addition of dissimilar material into a waste container complicates the efficient handling of the waste, may increase handling costs, and may compromise the safety of all waste handlers. You **must** keep foreign matter and undissolved solids out of waste containers.

- Do not add:
  - Pipette tips
  - Needles
  - Filter paper
  - Precipitates or other undissolved solids
  - Biological material
- Collect liquid waste in liquid waste containers and collect solid waste in its appropriate container.

Contact HMM for special handling or processing of acidic or caustic liquids.

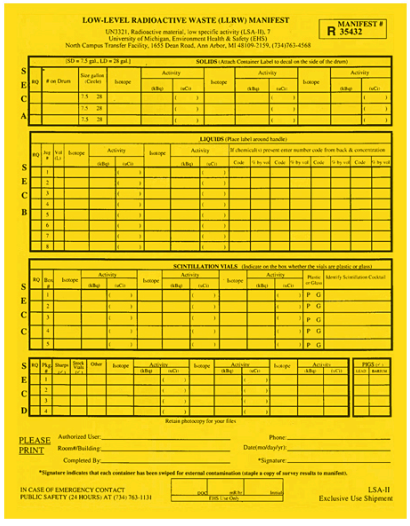
Supplies Available through HMM

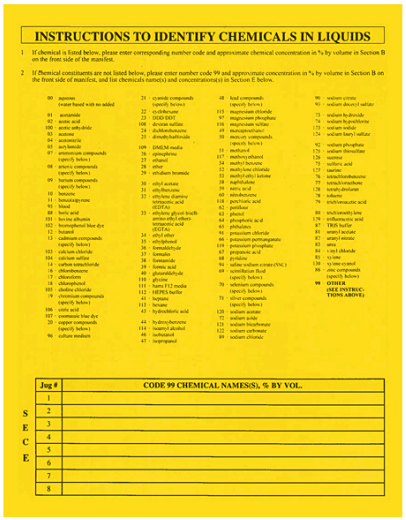
HMM provides the following supplies. To order these supplies, complete the EHS Supplies Request Form or call (734) 763-4568.

- 4 liter plastic jugs
- 20 liter plastic jugs

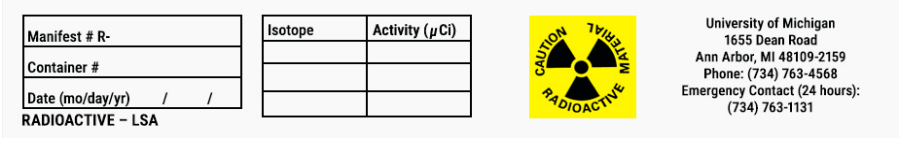
NOTE: Obtain approval from HMM before using glass or other containers for waste.

- LLRW Manifest





- Radioactive Waste Label



Preparing Jugs for Collection

When preparing liquid waste jugs for collection, ensure:

- The liquid waste container is not filled above the inscribed line.

NOTE: If the container does not have a line, or if the line is faded, do not fill the container beyond the area of the jug where it begins to taper to the jug's mouth. An overfilled jug is more likely to spill and spread contamination.

- The waste jug is **not** leaking.
- A radioactive contamination survey has been conducted to demonstrate the jug is free of external contamination.
- The cap is securely tightened to prevent spillage during collection and transportation.

Using the Waste Container

1. Use a funnel to decant liquid LLRW into jugs to prevent external contamination.
2. Segregate LLRW by isotope(s). Refer to Table of Acceptable Segregation Categories for Low-Level Radioactive Waste.

Procedure: Preparing Liquid LLRW for Collection

1. Analyze a 1-mL sample from each liquid LLRW jug in a liquid scintillation counter to ensure accurate reporting of radioisotope activity content.
2. Assign a number to each jug. Use 1-8 as preprinted on each manifest.
3. On the manifest, complete Section B and the Authorized User and location information (see "Completing the LLRW Manifest" below).
4. Conduct a removable radioactive contamination survey of the following areas of the jugs:
    - Cap
    - Handle
    - Sides
    - Bottom
5. Is there evidence of removable radioactive contamination?
    - If YES, decontaminate (clean) the outside of the jug and repeat step 4.
    - If NO, go to the next step.
6. Make a copy of the manifest and radioactive contamination survey results for your records.
7. Staple a copy of the radioactive contamination survey results to the manifest.
8. Complete the container label and insert it through the handle and affix the two adhesive ends together.
9. Place the manifest in a location where it is visible for collection and where it will **not** become contaminated.
10. Request a waste collection from HMM using one of the following methods:
    - Call HMM at (734) 763-4568
    - Complete the online Supply Request or Waste Pickup Form listed on the EHS Homepage

Denying Waste Collection

EHS may choose **not** to collect waste jugs or may return jugs to the laboratory of origin for repackaging if any of the following unacceptable conditions are noted:

- External contamination detected on jugs.
- Isotopes(s), activity, or chemical content in the waste jugs are inconsistent with those identified by the waste generator.
- Bi-phasic mixture of liquids in waste jug.
- Cap on jug is **not** an EHS-approved cap.
- Solid material discovered in jug (pipette tips, filter paper, needles, biological material, etc.).

- Jugs filled beyond inscribed line.
- Jugs bloated (positive pressure) or crumpled (negative pressure).
- Writing or defacing noted on jug surface.

Preparing Sharps LLRW for Collection

Sharps are objects which represent a puncture or laceration hazard; the following are examples:

- Needles
- Scalpels
- Intravenous tubing with needle attached
- Blades (razor, X-Acto knife)
- Capillary tubes and pipettes
- Sharp metal objects
- Broken glass objects

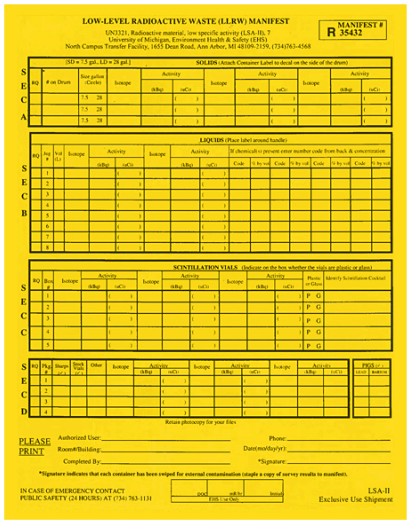
Supplies Available through HMM

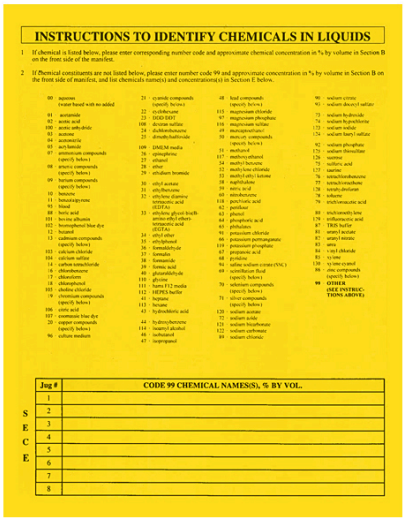
HMM provides sharps containers. To order sharps containers, call (734) 763-4568 or Complete the EHS Supplies Request Form .

- **1-gallon sharps container**

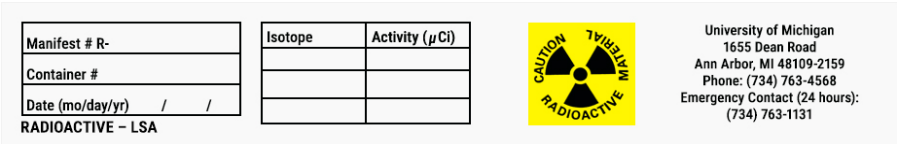
- **5-gallon sharps container**

- LLRW Manifest





- Radioactive Waste Label



Denying Waste Collection

Sharps are **not** to be placed into yellow LLRW fiber drums for disposal. Sharp objects discovered in yellow LLRW fiber drums will result in the drum being returned to the laboratory of origin for proper segregation and repackaging.

Using the Waste Container

- Segregate sharps LLRW by isotope(s).
- Securely close (i.e., snap in place) the container to prevent radioactive material from leaking from conditions normally incident to transportation.

Procedure: Preparing Sharps LLRW for Collection

1. Assign a number to each pail or box. Use 1-8 as preprinted on each manifest.
2. On the manifest, complete Section D and the Authorized User and location information (see “Completing the LLRW Manifest” below).
3. Conduct a removable radioactive contamination survey of the following places on each sharps pail or HMM-approved commercially-available container:
    - Pail: Lid, handle, sides, and bottom
    - HMM-approved commercially-available containers: All four sides, top, and bottom
4. Is there evidence of removable radioactive contamination?
    - If YES, decontaminate (clean) the outside of the pail or HMM-approved commercially-available container and repeat step 5.
    - If NO, go to the next step.

5. Make a copy of the manifest and radioactive contamination survey results for your records.
6. Staple a copy of the radioactive contamination survey results to the manifest.
7. Place container label around the handle of the pail and affix the two adhesive ends together or on top of the HMM-approved commercially-available container.
8. Place the manifest in a location where it is visible for collection and where it will **not** become contaminated.
9. Request a waste collection from HMM using one of the following methods:
    - Call HMM at (734) 763-4568
    - Complete the online EHS Waste Pickup Request form

Preparing Lead- and Barium-Impregnated Pigs and Objects Containing Lead or Barium for Collection

EHS collects lead- and barium-shielded containers ("pigs"), bricks, sheets, and objects impregnated with lead or barium for disposal.

Packaging

Lead- and barium-impregnated pigs **must** be in a sturdy box, taped securely shut, and marked "LEAD PIGS" or "BARIUM PIGS."

Objects containing lead or barium **must** also be in a sturdy box and taped securely shut.

Procedure: Preparing Lead- and Barium- Impregnated Pigs for Collection

1. Conduct a removable radioactive contamination survey of all sides or surfaces of the lead- or barium-impregnated pigs.
2. Is there evidence of removable radioactive contamination?
    - If YES, decontaminate (clean) the lead object and repeat step 1.
    - If NO, go to the next step.
3. Place lead- or barium-impregnated pigs in a sturdy box.
4. Seal the box securely with lab, duct, or masking tape (**not** "Caution: Radioactive Material" tape).
5. On the manifest, complete Section D--Pigs and the Authorized User and location information (see "Completing the LLRW Manifest" below).
6. Make a copy of the manifest and radioactive contamination survey results for your records.
7. Staple a copy of the radioactive contamination survey results to the manifest.
8. Place the manifest in a location where it is visible for collection and where it will **not** become contaminated.
9. Request a waste collection from HMM using one of the following methods:
    - Call HMM at (734) 763-4568
    - Complete the online Waste Pickup Request form

Procedure: Preparing Objects Containing Lead or Barium for Collection

1. Conduct a removable radioactive contamination survey of all sides or surfaces of the lead- or barium-objects.
2. Is there evidence of removable radioactive contamination?

- If YES, decontaminate (clean) the lead or barium object and repeat step 1.
- If NO, go to the next step.

3. Place objects containing lead or barium in a sturdy box.
4. Seal box securely with lab, duct, or masking tape (**not** "Caution: Radioactive Material" tape).
5. Place radioactive contamination survey results in a location where they are visible for collection and where they will **not** become contaminated.

   NOTE: Objects containing lead or barium do not need a manifest.
6. For oversized items that cannot be boxed, contact HMM for packaging instructions.
7. Request a waste collection from HMM using one of the following methods:
   - Call HMM at (734) 763-4568
   - Complete the online Waste Pickup Request form

Preparing Animal Carcasses and Tissues Contaminated with Radioactive Material for Collection

Use this procedure to prepare animal carcasses and tissues contaminated with radioactive material for collection. Examples of this Waste Stream include the following:

- Animal carcasses
- Blood
- Organs
- Tissues
- Body parts other than teeth
- Products of conception
- Urine/feces
- Bedding

Freezer

Animal carcasses and animal tissue waste **must** be completely frozen prior to collection. Place bags holding carcasses in a freezer designated for animals containing radioactive material.

Authorized Users must notify RSS in writing when planning to store radioactive pathological material in an animal freezer under the authorization of another individual or department.

NOTE: Contact RSS if a radioactive storage freezer is filled to capacity, breaks down, or otherwise becomes ineffective in completely freezing animal carcasses, tissues, blood, etc.

Biological Radioactive Waste Containing Other Hazards

Radioactive blood, tissue, urine, etc. **must** be rendered innocuous or non-toxic prior to HMM collection (e.g., using bleach, detergent, and other methods).

WARNING: Radioiodines or other volatile compounds may become airborne when bleach is added.

NOTE: Authorized Users **must** have EHS approval to generate biohazardous, chemically toxic, or carcinogenic materials in animal tissue. Special handling instructions or precautions **must** be provided to HMM when requesting waste collections containing pathological, toxic, or carcinogenic material.

Reducing Volatile Nature of Radioiodines

Acidic solutions or strong oxidizers (e.g., bleach) enhances the volatile nature of radioiodines (e.g., sodium iodide [NaI]).

To reduce the volatility of the radioiodines in fluids such as urine or blood, add approximately 500 mL of sodium thiosulfate ($Na_2S_2O_3$) in waste jugs containing liquid radioiodines. The sodium thiosulfate binds free or volatile radioiodine and reduces volatility.

NOTE: Do **not** mix bleach with radioiodines; bleach enhances the volatile nature of radioiodines. Use other EPA-approved disinfectants (e.g., Lysol) to control odors and eliminate pathogens.

I-125 and I-131

Do **not** discard ≥ 5.0 mCi of I-125, I-131, or both in a single bag or container of biological waste unless approved by RSS in advance.

Animal Cages

Plastic animal cages are **not** considered pathological waste. Follow the procedure Preparing Animal Waste and Bedding Contaminated with Radioactive Material for Collection, then decontaminate the cages.

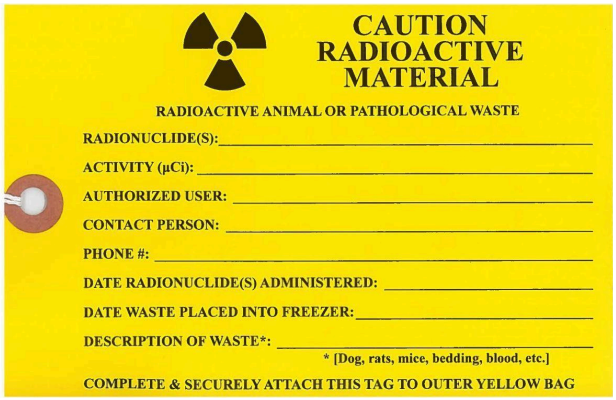
For more information about decontaminating cages, refer to Responsibilities to Decontaminate Animal Cages and Pens Used with Radioactive Materials.

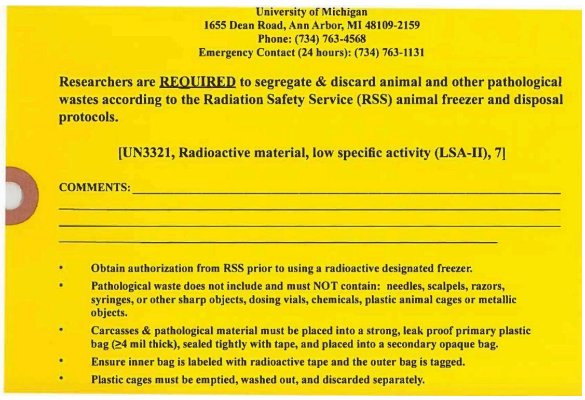
Supplies Available through HMM

RSS provides the following supplies to collect radioactive animal carcasses, tissues, and bedding. To order these supplies, call (734) 763-4568 or complete the online Supplies Request Form**.**

- Yellow opaque plastic bags (4 mil)

- "Caution Radioactive Material - Radioactive Animal or Pathological Waste" tag





NOTE: Do not place radioactive animal carcasses and tissues into:

- Yellow fiber drums used for solid LLRW
- Glass containers

Procedure: Preparing Animal Carcasses and Tissues Contaminated with Radioactive Material for Collection

To prepare animal carcasses and tissues contaminated with radioactive material for collection:

1. Remove all sharps (needles, razors, scalpels, etc.) and metallic objects from carcasses.
2. Double-bag carcasses and tissues in 4 mil plastic bags.
3. Place carcass tissues in the leak-proof yellow plastic bag.
4. Seal the bag tightly with "Caution: Radioactive Material" tape.
5. Complete and attach the “CAUTION RADIOACTIVE MATERIAL: RADIOACTIVE ANIMAL OR PATHOLOGICAL WASTE” tag on the bag with the following information:
   - Radionuclide(s)
   - Activity (mCi)
   - Authorized User / Investigator’s Name
   - Contact person and phone number
   - Date Radionuclide(s) administered
   - Date waste placed into freezer
   - Description of waste (such as dogs, rats, mice, bedding, blood)
   - Comments
6. Place the bag in a freezer designated for animals containing radioactive material.
7. Call HMM at (734) 763-4568 for collection.

Accepted Liquid Scintillation Fluids (Cocktails)

EHS approves which liquid scintillation cocktails can be used for research. Refer to the following table for a list of these liquid scintillation cocktails.When ordering liquid scintillation cocktails, verify the name of the liquid scintillation cocktail being ordered. Some manufacturers make a family of liquid scintillation cocktails with similar names, but with different properties; therefore, making one an approved liquid scintillation cocktail, but other variations are not approved.To request approval to use a liquid scintillation cocktail not listed in the table below, contact HMM at (734) 763-4568. HMM may issue special handling and processing instructions for the liquid scintillation cocktail.

Cocktail Names and Manufacturers

- **Ready Safe -** Beckman
- **Scintisafe 30% -** Fisher Scientific
- **Scintisafe Plus 50% -** Fisher Scientific
- **Scintisafe Econo F -** Fisher Scientific
- **Scintisafe Econo 1 -** Fisher Scientific
- **Scintisafe Econo 2 -** Fisher Scientific
- **Scintisafe Gel -** Fisher Scientific
- **Scintiverse BD -** Fisher Scientific
- **BSC -** GE Healthcare (Amersham)
- **In-Flow 2:1 -** IN/US Systems, Inc**.**
- **ProSafe FC+ -** Meridian Biotechnologies
- **ProSafe+ -** Meridian Biotechnologies
- **ProSafe HC+ -** Meridian Biotechnologies
- **ProSafe TS+ -** Meridian Biotechnologies
- **ProFlow G+ -** Meridian Biotechnologies
- **ProFlow P+ -** Meridian Biotechnologies
- **BetaMax ES -** MP Biomedicals (ICN)
- **CytoScint ES -** MP Biomedicals (ICN)
- **Ecolite (+) -** MP Biomedicals (ICN)
- **EcoLume -** MP Biomedicals (ICN)
- **UniverSol ES -** MP Biomedicals (ICN)
- **Ecoscint H** - National Diagnostics
- **Ecoscint O** - National Diagnostics
- **Beta Plate Scint -** Perkin Elmer (Wallac)
- **Formula 989 -** Perkin Elmer (Packard)
- **MicroScint O -** Perkin Elmer (Packard)
- **MicroScint 20 -** Perkin Elmer (Packard)
- **Opti-fluor -** Perkin Elmer (Packard)
- **Opti-fluor O -** Perkin Elmer (Packard)
- **OptiPhase HiSafe 2 -** Perkin Elmer (Packard)
- **OptiPhase Super Mix -** Perkin Elmer (Packard)
- **Ultima Gold -** Perkin Elmer (Packard)
- **Ultima AB -** Perkin Elmer (Packard)
- **Ultima Gold F -** Perkin Elmer (Packard)
- **Ultima Gold MV -** Perkin Elmer (Packard)
- **Ultima Gold XR -** Perkin Elmer (Packard)
- **Ultima Flo AF -** Perkin Elmer (Packard)
- **Ultima Flo AP -** Perkin Elmer (Packard)
- **Ultima Flo M -** Perkin Elmer (Packard)
- **Bio-Safe II -** Research Products Intl.
- **Bio-Safe NA -** Research Products Intl.
- **Econo-Safe -** Research Products Intl.

Preparing Liquid Scintillation Vials for Collection

HMM will collect empty, filled, or partially-filled liquid scintillation vials containing EHS-approved non-hazardous or biodegradable scintillation fluid, provided the vials are sorted, packaged, and prepared according to the methods described below.

Using Non-Approved Liquid Scintillation Fluids

To obtain approval to use a scintillation cocktail that is not on the approved list contact HMM at (734) 763-4568.

Temporary authorization may be granted to use a non-approved scintillation cocktail if there is a valid research need to use a specific product or type of cocktail. Non-approved scintillation cocktails may require additional handling and packaging requirements, such as decanting into specialty containers.

NOTE: Toluene and xylene-based scintillation fluids are prohibited unless authorization has been received from EHS. Contact HMM for specific collection instructions.

Segregating Liquid Scintillation Vials

To segregate liquid scintillation vials:

- Segregate vials by isotope content; refer to the Table of Acceptable Segregation Categories for Low-Level Radioactive Waste.
- Segregate glass and plastic vials of the same isotope content.
- Use a separate tray and box for each isotope content and the type of container they are in.

Improper Liquid Scintillation Vials Disposal

The following disposal methods are prohibited:

- Discarding scintillation fluid or isotopes down sanitary drains.
- Discarding scintillation vials with solid waste.
- Disposing of commercially- prepared liquid scintillation standards with other scintillation vial wastes.

NOTE: Contact EHS to request a special collection.

Boxes for Liquid Scintillation Vials

The boxes used to package liquid scintillation vials for disposal **must** be undamaged, sturdy, and properly sealed to prevent breakage or leakage of contents. Users will be asked to repackage boxes of scintillation vials saturated with or leaking scintillation fluid.

What NOT to Place in Boxes

The following items **must** NOT be placed in boxes containing liquid scintillation vials:

- Other forms of LLRW (gloves, syringes, paper, pads, etc.)
- Radioactive material stock vials

Procedure: Preparing Liquid Scintillation Vials for Collection

1. Segregate liquid scintillation vials by isotope(s).
2. Segregate vials of the same isotope by type of vial (glass or plastic).
3. Ensure scintillation vial caps are fastened securely and not leaking prior to packaging in trays and boxes.
   NOTE: Do NOT tape the tops of scintillation vials.
4. Did the vials come in a flat tray?
   - If YES, place the vials in a flat tray.
   - If NO, place the vials in a plastic bag, then inside a sturdy box.
5. Place absorbent material in the bottom of the appropriate box:
   - If the vials are in a flat tray, place the absorbent pad in the original vial box.
   - If the vials are in a plastic bag (and box), place the absorbent pad in a sturdy box.
6. Pack vial flats or plastic bag containing scintillation vials the appropriate box.
7. Seal box securely with lab, duct, or masking tape (**not** “Caution: Radioactive Material” tape).
8. Write on the top of the box whether the liquid scintillation vials are made of plastic or glass.
9. Assign a number to each box. Use 1-8 preprinted on each manifest.

10. On the manifest, complete Section C and the Authorized User and location information (see "Completing the LLRW Manifest" below).
11. Conduct a removable radioactive contamination survey for the following areas for each box:
    - All four sides
    - Top
    - Bottom
12. Is there evidence of removable radioactive contamination?
    - If YES, decontaminate (clean) the outside of the box and repeat step 11.
    - If NO, go to the next step.
13. Make a copy of the manifest and radioactive contamination survey results for your records.
14. Staple a copy of the radioactive contamination survey results to the manifest.
15. Complete the container label and affix it to the top of the box.
16. Place the manifest in a location where it is visible for collection and where it will **not** be contaminated.
17. Request a waste collection from HMM using one of the following methods:
    - Call HMM at (734) 763-4568
    - Complete the online Waste Pickup Request form

Preparing Stock Vials for Collection

Empty radioactive material stock vials with no visible residue can be disposed of in fiber drums as solid waste.

Containers

Place stock vial in a closeable container that is sufficiently strong enough to hold it, such as a strong, durable carton or a pail with lid. HMM can supply plastic pails at no charge, upon request.

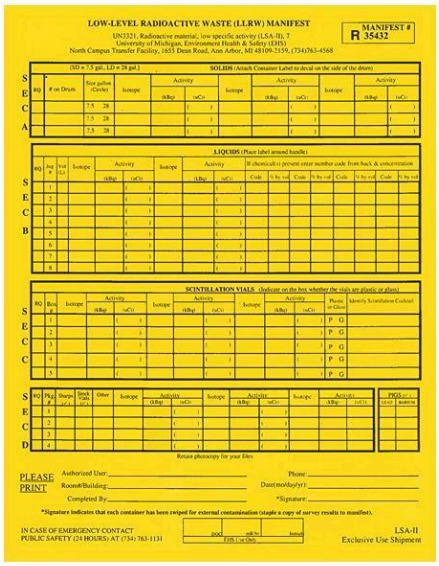
Line the container with a plastic bag or place an absorbent plastic-backed pad (e.g., blue pad or Benchkote®) on the bottom of the container to contain or absorb any liquid that may leak.

Supplies Available through HMM

HMM provides the following supplies to collect stock vial waste. To order these supplies, call (734) 763-4568 or complete the online Supplies Request Form.

- 1-gallon pail
- 5-gallon pail

- LLRW Manifest



LOW-LEVEL RADIOACTIVE WASTE (LLRW) MANIFEST

MANIFEST # R 35432

UN3321, Radioactive material, low specific activity (LSA-II), 7
University of Michigan, Environment Health & Safety (EHS)
North Campus Transfer Facility, 1655 Dean Road, Ann Arbor, MI 48109-2159, (734)763-4568

SOLIDS (Attach Container Label to decal on the side of the drum)

LIQUIDS (Place label around handle)

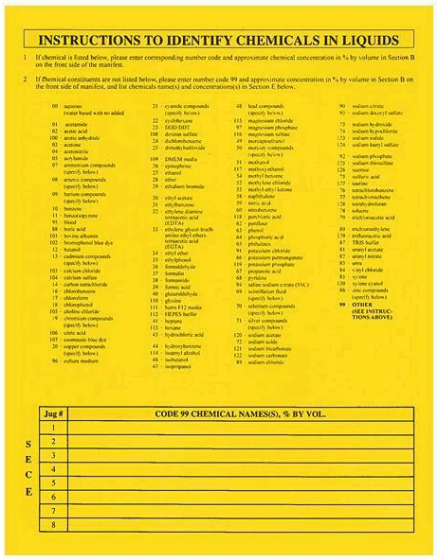
SCINTILLATION VIALS (Indicate on the box whether the vials are plastic or glass)

PLEASE PRINT Authorized User: Phone: Room#/Building: Date(mo/day/yr): Completed By: *Signature:

*Signature indicates that each container has been swiped for external contamination (staple a copy of survey results to manifest).

IN CASE OF EMERGENCY CONTACT PUBLIC SAFETY (24 HOURS) AT (734) 763-1131

LSA-II
Exclusive Use Shipment



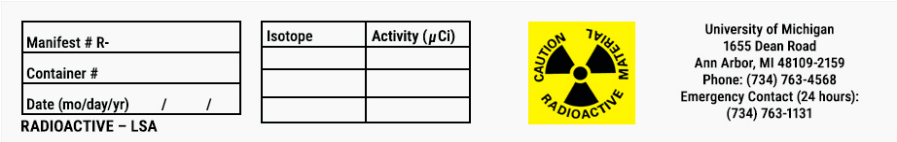
INSTRUCTIONS TO IDENTIFY CHEMICALS IN LIQUIDS

1 If chemical is listed below, please enter corresponding number code and approximate chemical concentration in % by volume in Section B on the front side of the manifest.

2 If chemical constituents are not listed below, please enter number code 99 and approximate concentration in % by volume in Section B on the front side of manifest, and list chemicals name(s) and concentration(s) in Section E below.

Jug #	CODE 99 CHEMICAL NAMES(S), % BY VOL.
1	
2	
3	
4	
5	
6	
7	
8	

- Radioactive Waste Label



Manifest # R-
Container #
Date (mo/day/yr) / /

RADIOACTIVE – LSA

Isotope	Activity (μCi)

CAUTION RADIOACTIVE MATERIAL

University of Michigan
1655 Dean Road
Ann Arbor, MI 48109-2159
Phone: (734) 763-4568
Emergency Contact (24 hours):
(734) 763-1131

Using the White Pail

1. Segregate stock vials by isotope(s).
2. Line the pail with a plastic bag or place lined absorbent pads (blue pads or Benchkote®) on the bottom of the container.
3. Place stock vials in the container.

Procedure: Preparing Stock Vials for Collection

1. If using a box, seal it securely with lab, duct, or masking tape (**not** "Caution: Radioactive Material" tape).
2. Assign a number to each container. Use 1-4 as preprinted on each manifest.
3. On the manifest, complete Section D and the Authorized User and location information (see "Completing the LLRW Manifest" below).
4. Conduct a removable radioactive contamination survey. Swipe the following areas:
    - If using a box:
        - All four sides
        - Top
        - Bottom
    - If using the white pail: Lid, handle, sides, and bottom
5. Is there evidence of removable radioactive contamination?
    - If YES, decontaminate (clean) the outside of the container and repeat step 4.
    - If NO, go to the next step.
6. Make a copy of the manifest and radioactive contamination survey results for your records.
7. Staple a copy of the radioactive contamination survey results to the manifest.
8. Complete the container label and affix it to the appropriate location:

- Box: Affix on the top of the box.
- Pail: Place around the handle and affix the two adhesive ends together.

9. Place manifest in a location where it is visible for collection and where it will **not** become contaminated.
10. Request a waste collection from HMM using one of the following methods:
    - Call HMM at (734) 763-4568
    - Complete the online Supply Request or Waste Pickup Form listed on the EHS Homepage

Completing the LLRW Manifest

The LLRW manifest provides a profile and a record of the types (solid, liquid, scintillation vials, sharps, and stock vials) and quantities of LLRW prepared for collection.

Procedure: Completing Section A—SOLIDS

1. Record the assigned solid waste drum **Number** on each solid waste drum.

   NOTE: Solid waste drums have an assigned number, which is located on the side of the drum. Large drum numbers begin with "LD," small drum numbers begin with "SD."
2. Circle the applicable solid waste drum size:
   - Small solid waste drums = 7.5 or SD
   - Large solid waste drums = 28 or LD
3. Record the **Isotope(s)** and **Activity(s) (µCi)** of each isotope in the solid waste drum. The following example shows how the manifest looks when Section A is complete:

SECTION A — SOLIDS (Place Container Label on decal on side of yellow fiber drum.)

RQ	# on Drum	Size (Circle)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)
	LD-5125	SD (LD)	H-3		200	C-14		120			
	SD-5364	(SD) LD	S-35		130	P-33		60	Cr-51		35
	LD-5394	SD (LD)	P-32		90						

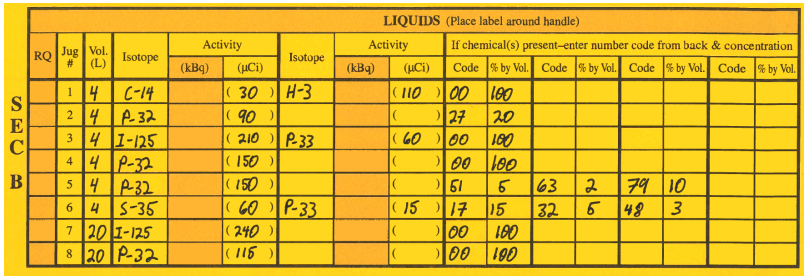
4. Complete the next applicable section.

Procedure: Completing Section B—LIQUIDS

1. In the **Vol (L)** box, indicate, using whole numbers, the volume of liquid (liters) in each individual liquid waste jug.
2. Record the **Isotope(s)** and corresponding **Activity(s) (µCi)** of the liquid waste within each liquid waste jug.
3. Refer to the back of the manifest and use the table to describe the chemical constituents of the liquid contained within each liquid LLRW jug.

   - If the liquid LLRW contains a chemical listed on the back of the manifest:
     - In the **Code** box, write the corresponding code.
     - In the **% by vol** box, write the percentage of the corresponding chemical, then go to the next step.
   - If the liquid LLRW contains a chemical that is NOT listed on the back of the manifest:
     - In the **Code** box, write 99.
     - In the **% by vol** box, write the percentage of that chemical contained in the liquid waste jug.
     - On the back of the manifest, in Section E, write the name of each chemical in the liquid waste jug NOT listed on the back of the manifest.
   - If the liquid LLRW does not contain ANY added chemicals:
     - In the **Code** box, write 00.
     - In the **% by vol** box, write the percentage of water in the waste.

Each container of liquid **must** be described by a code to ensure the liquid is profiled accurately and completely. The following example shows how the manifest looks when Section B is complete:



LIQUIDS (Place label around handle)

SECB	RQ	Jug #	Vol. (L)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	If chemical(s) present–enter number code from back & concentration: Code	% by Vol.	Code	% by Vol.	Code	% by Vol.	Code	% by Vol.
		1	4	C-14		(30)	H-3		(110)	00	100						
		2	4	P-32		(90)			( )	27	20						
		3	4	I-125		(210)	P-33		(60)	00	100						
		4	4	P-32		(150)			( )	00	100						
		5	4	P-32		(150)			( )	51	5	63	2	79	10		
		6	4	S-35		(60)	P-33		(15)	17	15	32	5	48	3		
		7	20	I-125		(240)			( )	00	100						
		8	20	P-32		(115)			( )	00	100						

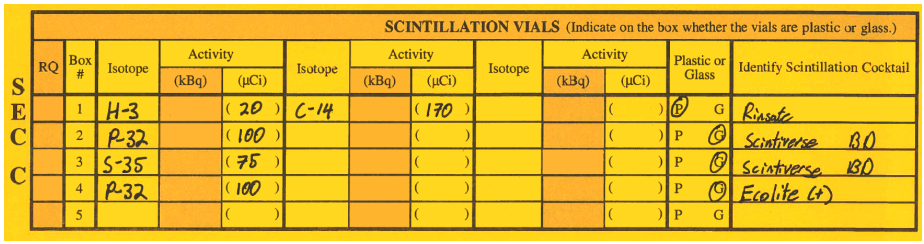
4. Complete the next applicable section.

Procedure: Completing Section C—Scintillation Vials

1. Record the **Isotope(s)** and corresponding **Activity(s) (µCi)** for each box scintillation vials.
2. Circle the correct type of vials in the scintillation vials box:
   - If the vials are plastic, circle **P**.
   - If the vials are glass; circle **G**.
   - If a multi-well tray, write and circle a "**T**" between the "**P**" and "**G**."
3. In the **Identify Scintillation Cocktail** box, write the name of the liquid scintillation cocktail that is in the vials.

NOTE: Write "Empty" if no cocktail is used OR the vial once contained a cocktail, but the contents were decanted into another container.

The following example shows how the manifest looks when Section C is complete:



SCINTILLATION VIALS (Indicate on the box whether the vials are plastic or glass.)

SECC	RQ	Box #	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Plastic or Glass	Identify Scintillation Cocktail
		1	H-3		(20)	C-14		(170)			( )	(P) G	Ringsafe
		2	P-32		(100)			( )			( )	P (G)	Scintiverse BD
		3	S-35		(75)			( )			( )	P (G)	Scintiverse BD
		4	P-32		(100)			( )			( )	P (G)	Ecolite (+)
		5			( )			( )			( )	P G	

4. Complete the next applicable section.

Procedure: Completing Section D—Sharps, Stock Vials, Lead Pigs, Other Forms

1. Is the LLRW in the form of sharps or stock vials?
   - If YES, write a **checkmark** in the appropriate box, record the **Isotope(s)** and corresponding **Activity(s)** for each container.
   - Go to the next step.
2. Is the LLRW in some other form?
   - If YES, consult with HMM for more information about how to prepare the LLRW for collection.
   - Go to the next step.
3. Does the LLRW consist of lead or barium "pigs" (small shields for stock vials)?
   - If YES, and the pigs contain lead or barium, place a **checkmark** in the appropriate box, then go to the next step.
   - Go to the next step.

The following example shows how the manifest looks when Section D is complete:

S E C D	RQ	Pkg. #	SHARPS (✔)	STOCK VIALS (✔)	OTHER	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	PIGS (✔) LEAD	PIGS (✔) BARIUM
		1		✓		P-32		(600)	S-35		(450)			( )		
		2		✓		I-125		(420)			( )			( )		
		3	✓			H-3		(190)	C-14		(60)			( )		
		4	✓			Co-57		(55)	Ca-45		(140)	Na-22		(100)		

4. Complete the next applicable section.

Procedure: Completing the Authorized User and Location Information

1. Complete the following contact information:
    - Authorized User: The RSS-approved Authorized User
    - Phone: The telephone number of the laboratory
    - Room #/Building: The room number and building name
2. Write the date the manifest was prepared.
3. Print your name.
4. Sign the manifest attesting that each container has undergone a radioactive contamination survey and is free of removable contamination.

The following example shows how the manifest looks when the Authorized User and location information is completed:

PLEASE PRINT

Authorized User: John Smith Phone: 763-4668

Room #/Building: 4100 MSRB III Date (mo/day/yr): 2/11/2026

Completed By: John Doe *Signature: John

*Signature indicates that each container has been swiped for external contamination (staple copy to manifest).

IN CASE OF EMERGENCY CONTACT
PUBLIC SAFETY (24 HOURS) AT (313) 763-1131

DOC	mR/hr	INITIALS
OSEH Use Only		

LSA-II
Exclusive Use Shipment

5. Attach a copy of the radioactive contamination survey to the manifest.

Example of Properly Completed Manifest

LOW-LEVEL RADIOACTIVE WASTE (LLRW) MANIFEST
Radioactive material, LSA, n.o.s., 7, UN2912 _____
University of Michigan • Occupational Safety and Environmental Health (OSEH)
North Campus Transfer Facility • 1655 Dean Road • Ann Arbor, MI 48109-2159 • (313) 763-4568

MANIFEST # R 23292

SECTION A — SOLIDS (Place Container Label on decal on side of yellow fiber drum.)

RQ	# on Drum	Size (Circle)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)
	LD-6125	SD (LD)	H-3		(200)	C-14		(120)			( )
	SD-5364	(SD) LD	S-35		(130)	P-33		(60)	Cr-51		(35)
	LD-5394	SD (LD)	P-32		(90)			( )			( )

SECTION B — LIQUIDS (Place label around handle)

RQ	Jug #	Vol. (L)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	If chemical(s) present–enter number code from back & concentration: Code	% by Vol.	Code	% by Vol.	Code	% by Vol.	Code	% by Vol.
	1	4	C-14		(30)	H-3		(110)	00	100						
	2	4	P-32		(90)			( )	27	20						
	3	4	I-125		(210)	P-33		(60)	00	100						
	4	4	P-32		(150)			( )	00	100						
	5	4	P-32		(150)			( )	51	5	63	2	79	10		
	6	4	S-35		(60)	P-33		(15)	17	15	32	5	48	3		
	7	20	I-125		(240)			( )	00	100						
	8	20	P-32		(115)			( )	00	100						

SECTION C — SCINTILLATION VIALS (Indicate on the box whether the vials are plastic or glass.)

RQ	Box #	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Plastic or Glass	Identify Scintillation Cocktail
	1	H-3		(20)	C-14		(170)			( )	(P) G	Ricsafe
	2	P-32		(100)			( )			( )	P (G)	Scintiverse BD
	3	S-35		(75)			( )			( )	P (G)	Scintiverse BD
	4	P-32		(100)			( )			( )	P (G)	Ecolite (+)
	5			( )			( )			( )	P G	

SECTION D

RQ	Pkg. #	SHARPS (✓)	STOCK VIALS (✓)	OTHER	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	Isotope	Activity (kBq)	Activity (µCi)	PIGS (✓) LEAD	PIGS (✓) BARIUM
	1		✓		P-32		(600)	S-35		(450)			( )		
	2		✓		I-125		(420)			( )			( )		
	3	✓			H-3		(190)	C-14		(60)			( )		
	4	✓			Co-57		(65)	Ca-45		(140)	Na-22		(100)		

PLEASE PRINT
Authorized User: John Smith
Phone: 763-4568
Room #/Building: 4100 MSRB III
Date (mo/day/yr): 2/11/2026
Completed By: John Doe
*Signature: John Doe

*Signature indicates that each container has been swiped for external contamination (staple copy to manifest).

IN CASE OF EMERGENCY CONTACT
PUBLIC SAFETY (24 HOURS) AT (313) 763-1131

DOC	mR/hr	INITIALS
OSEH Use Only		

LSA-II
Exclusive Use Shipment

INSTRUCTIONS TO IDENTIFY CHEMICALS IN LIQUIDS

1 If chemical is listed below, please enter corresponding number code and approximate chemical concentration in % by volume in section B on the **front** side of manifest.

2 If chemical is not listed below, please enter number code **99** and approximate concentration in % by volume in section B on the **front** side of manifest, and list chemical name(s) and concentration(s) in Section E below (please list in same order as listed on front):

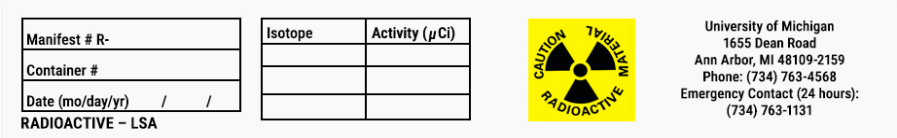
01 • acetamide
02 • acetic acid
100 • acetic anhydride
03 • acetone
04 • acetonitrile
05 • acrylamide
07 • ammonium compounds (specify below)
08 • arsenic compounds (specify below)
09 • barium compounds (specify below)
10 • benzene
11 • benzo(a)pyrene
95 • blood
88 • boric acid
101 • bovine albumin
102 • bromophenol blue dye
12 • butanol
13 • cadmium compounds (specify below)
103 • calcium chloride
104 • calcium sulfate
14 • carbon tetrachloride
16 • chlorobenzene
17 • chloroform
18 • chlorophenol
105 • choline chloride
19 • chromium compounds (specify below)
106 • citric acid
107 • coomassie blue dye
20 • copper compounds (specify below)
96 • culture medium
21 • cyanide compounds (specify below)
22 • cyclohexane
23 • DDD/DDT
108 • dextran sulfate
24 • dichlorobenzene
25 • dimethylsulfoxide (DMSO)
109 • DMEM media
26 • epinephrine
27 • ethanol
28 • ether
29 • ethidium bromide (EtBr)
30 • ethyl acetate
31 • ethylbenzene
32 • ethylene diamine tetraacetic acid (EDTA)
33 • ethylene glycol-bis (β-amino ethyl ether)-tetraacetic acid (EGTA)
34 • ethyl ether
35 • ethylphenol
36 • formaldehyde
37 • formalin
38 • formamide
39 • formic acid
40 • glutaraldehyde
110 • glycine
111 • hams F12 media
112 • HEPES buffer
41 • heptane
113 • hexane
43 • hydrochloric acid (HCl)
44 • hydroxybenzene
114 • isoamyl alcohol
45 • isobutane
46 • isobutanol
47 • isopropanol
48 • lead compounds (specify below)
115 • magnesium chloride
97 • magnesium phosphate
116 • magnesium sulfate
49 • mercaptoethanol
50 • mercury compounds (specify below)
51 • methanol
117 • methoxyethanol
54 • methyl benzene
52 • methylene chloride
53 • methyl ethyl ketone
58 • naphthalene
59 • nitric acid
60 • nitrobenzene
118 • perchloric acid
62 • periflour
63 • phenol
64 • phosphoric acid
65 • phthalates
91 • potassium chloride
66 • potassium permanganate
119 • potassium phosphate
67 • propanoic acid
68 • pyridine
94 • saline sodium citrate (SSC)
69 • scintillation fluid (specify below)
70 • selenium compounds (specify below)
71 • silver compounds (specify below)
120 • sodium acetate
72 • sodium azide
121 • sodium bicarbonate
122 • sodium carbonate
89 • sodium chloride
90 • sodium citrate
93 • sodium dodecyl sulfate (SDS)
73 • sodium hydroxide
74 • sodium hypochlorite
123 • sodium iodide
124 • sodium lauryl sulfate (SLS)
92 • sodium phosphate
125 • sodium thiosulfate
126 • sucrose
75 • sulfuric acid
127 • taurine
76 • tetrachlorobenzene
77 • tetrachloroethene
128 • tetrahydrofuran
78 • toluene
79 • trichloroacetic acid (TCA)
80 • trichloroethylene
129 • trifluoroacetic acid
87 • TRIS buffer
81 • uranyl acetate
82 • uranyl nitrate
83 • urea
84 • vinyl chloride
85 • xylene
130 • xylene cyanol
86 • zinc compounds (specify below)
99 • OTHER (SEE INSTRUCTIONS ABOVE)

SEE

Jug #	CODE 99 CHEMICAL NAME(S), % BY VOL.
1	
2	
3	
4	
5	
6	Lead Acetate
7	
8	

The Container Label

Complete and attach an identification label to each container of LLRW pending collection. The label associates the container to a LLRW manifest describing the contents of the container, along with other information necessary for transportation and disposal.



Each container label **must** include the following information:

- Manifest Number
  - The pre-printed number is located on the upper-right corner of the LLRW manifest.
- Container Number
  - A pre-designated number that can be found marked on the side of the drum. Large drum numbers begin with “LD” and small drum numbers begin with “SD.”
  - For liquid waste, scintillation vials, sharps, and stock vials, the line number on the manifest corresponding to the container entry.

- Date (month/day/year)
  - The date the manifest was prepared.
- Isotope/Activity
  - Each isotope in the container and its activity (µCi). This must match the associated information on the manifest for the container.

Placement of the container label:

- Solid waste drum
  - Affix label where it says, “Place container label here” on the side of the drum
- Liquid waste jug
  - Insert label through handle and affix the two adhesive ends together
- Scintillation vial box
  - Affix label to the top of the box
- Sharps
  - Pail: Place label around handle and affix the two adhesive ends together
  - Other commercially-available approved containers: Affix label to top of the container
- Stock vial
  - Box: Affix label to the top of the box
  - Pail: Place label around handle and affix the two adhesive ends together

Storage and Labeling

LLRW ***must*** be stored in HMM-provided or approved containers. The containers **must** be:

- Sufficiently strong to hold the waste
- Handled in a manner to minimize breakage and spillage
- Identified as containing radioactive material according to RSS guidelines

Proper Storage of Waste Containers

LLRW containers ***must*** be stored in a safe, secure, and easily identifiable location within your laboratory. HMM will inspect containers and documentation prior to collection.

Store LLRW in an area that will limit radiation exposure to laboratory personnel. Use appropriate shielding, if necessary. Contact RSS at (734) 647-1143 for recommended location and shielding of LLRW.

Containers

HMM supplies specific types of containers for different types of LLRW at no cost. Use these containers for LLRW.

NOTE: All containers ***must*** be labeled with “Caution: Radioactive Material” tape.

Type of LLRW, Container to Use, and Availability

- **Solid LLRW**
  - Small (7.5 gallon) or large (28 gallon) yellow fiber drum
    - HMM provides
- **Liquid LLRW**
  - 4 liter (1 gallon) or 20 liter (5 gallon) plastic jug
    - HMM provides
- **Scintillation vials**

    - Boxes
        - Use the original box
- **Sharps**
    - 1 gallon or 5 gallon plastic pail
        - HMM provides
    - Other commercially-available approved container
- **Stock vials**
    - Box
        - Any sturdy box
    - 1 gallon or 5 gallon plastic pail
        - HMM provides
- **Animals and related waste**
    - Yellow opaque plastic bag (4 mil)
        - HMM provides the bag and identification tags

Ordering Containers

To order the containers, contact HMM using one of the following methods:

- Call (734) 763-4568
- Complete the online Supply Request or Waste Pickup Form listed on the EHS Homepage.

To order the yellow opaque plastic bags and identification tags (for animals and animal waste), call (734) 647-1143.