Contents: Radioactive Waste Management

Effective Date: **August 2003**

Point of Contact: Radioactive Waste Program Manager

Exhibits

Forms

Training Requirements and Reporting Obligations

This subject area contains training requirements. See the Training and Qualifications Web Site.

This subject area may or may not contain reporting obligations. See the subject area until obligations are listed here.

References

40 CFR 261, Identification and Listing of Hazardous Waste

DOE Order 435.1, *Radioactive Waste Management*

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques*

EM-SOP-105, Request for Sampling and Supplemental Health and Safety Plan

EM-SOP-109, Chain of Custody Procedure

EPA's Technology Innovation Office Clu-In web page

ESD Environmental Monitoring SOPs web page

Material Safety Data Sheet (MSDS) Search, Chemical Management System web site (*Limited Access)

Mixed Waste Management Subject Area

Radioactive Waste Management Basis Program Description

Radiological Control Manual Program Description

Records Management Subject Area

Regulated Medical Waste Management Subject Area

Spill Response Subject Area

Training and Qualifications Web Site

*Access Limited to BNL Staff and Authorized non-BNL Staff

Standards of Performance

All staff and guests shall comply with applicable Laboratory policies, standards, and procedures, unless a formal variance is obtained.

All staff and guests shall promptly report accidents, injuries, ES&H deficiencies, emergencies, and off-normal events in accordance with procedures.

Managers shall analyze work for hazards, authorize work to proceed, and ensure that work is performed within established controls.

Managers shall ensure that work is planned to prevent pollution, minimize waste, and conserve resources, and that work is conducted in a cost-effective manner that eliminates or minimizes environmental impact.

Before waste is generated, managers shall ensure that it has a funded and available disposition pathway. Managers shall ensure that all hazardous materials and waste have an identified owner who is accountable for its proper disposition.

All staff and users shall identify, evaluate, and control hazards in order to ensure that work is conducted safely and in a manner that protects the environment and the public.

All staff and users shall ensure that they are trained and qualified to carry out their assigned responsibilities, and shall inform their supervisor if they are assigned to perform work for which they are not properly trained or qualified.

All staff and users shall ensure that environmental effluents, emissions, and wastes associated with their work are as low as reasonably achievable (also referred to as "E-ALARA").

Management System

Management System

This subject area belongs to the **Environmental Management System** management system.

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The only official copy of this file is the one online in SBMS. Before using a printed copy, verify that it is the most current version by checking the document effective date on the BNL SBMS website.

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Disclaimer

Introduction: Radioactive Waste Management

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Brookhaven National Laboratory (BNL) is committed to integrating environmental stewardship into all facets of our missions. This stewardship includes the proper management of all radioactive waste streams created during the performance of BNL operations and research programs.

This subject area describes how Departments/Divisions at BNL identify, package, label, and manage radioactive waste to eliminate or minimize the impact on the environment. The following topics are discussed in this subject area:

- Segregating waste;
- Packaging waste;
- Labeling waste;
- Identifying/characterizing waste;
- Establishing and operating a Radioactive Waste Accumulation Area;
- Completion of Radioactive Waste Control Forms (RWCFs) and Accountable Nuclear Material Waste Control Forms (ANMWCFs);
- Decay in Storage (DIS);
- Accountable Nuclear Material/Waste;
- Waste certification;
- Processing radioactive liquid waste.

Requirements for managing radioactive waste are established in U.S. Department of Energy (DOE) Order 435.1, *Radioactive Waste Management*, requiring DOE organizations that generate radioactive waste to implement a waste certification program to ensure that waste acceptance criteria are met. The BNL Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description defines the program structure, logic, and methodology for waste certification. BNL's compliance with the applicable requirements of DOE Order 435.1 is accomplished by a DOE-approved Radioactive Waste Management Basis (RWMB) for Brookhaven National Laboratory in the Radioactive Waste Management Basis Program Description, which includes the exemption and timeframe requirements for the staging and storage of routine and nonroutine radioactive wastes. This document describes the BNL policies, procedures, plans, and controls demonstrating that BNL has the management systems, administrative controls, and physical controls established to comply with DOE Order 435.1. New or modified operations or activities that do not fall within the scope of the RWMB must be documented and approved prior to implementation. Organizations and/or generators should refer to the Work Planning and Control for Experiments and Operations Subject Area and inform Waste Management of any such proposed operations or activities.

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Subject Area: ***Radioactive Waste Management***

1. Generating Waste

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to all waste generators.

Required Procedure

Step 1	Ensure your training status as a generator of hazardous waste and radioactive waste is up-to-date. • To ensure you are within the two-year qualification period for the HP-RADIGEN (Radioactive Waste Generator) course, consult the Training and Qualifications Web Site, or contact your Department/Division's Training Coordinator. • If your training is not current, attend training in the proper methods for handling, documenting, and disposing of radioactive waste. For additional information on training requirements, contact the Radioactive Waste Program Manager.

Step 2	Segregate waste in accordance with the following
	
	• Segregate liquids from solids. For bulk Liquid Low- Level Radioactive Waste (LLLRW), refer to the section Processing Radioactive Liquid Waste for the Waste Management Program's processing criteria.
	• Segregate waste by waste classification:
	  ○ Low-Level Radioactive Waste (LLRW)
	  ○ Liquid Low-Level Radioactive Waste (LLLRW)
	  ○ Mixed Waste
	  ○ Accountable Nuclear Waste
	  ○ For other types of radioactive waste, contact your supervisor or the Radioactive Waste Program Manager

Program Manager.

- Segregate short half-life isotopes (less than 90 days) from long half-life isotopes for the Decay In Storage (DIS) Record.
- Segregate compactible waste from noncompactible waste.

Step 3

Place waste in Yellow LLRW Bag or other packaging (e.g., 55-gallon drum, carboy, B-12, B-25, or B-52 containers) approved for use by Waste Management (WM). For Liquid Low-Level Radioactive Waste (LLLRW), refer to the section Processing Radioactive Liquid Waste.

A Radioactive Waste Inventory Form must be maintained to ensure the documentation of a detailed inventory of the waste container when loading solid waste into a waste package (e.g., yellow LLRW bag, 55-gallon drum, B-12, B-25, or B-52), require a point of generation inspection conducted by a Waste Management Representative or designee.

- Collect radioactive waste only in containers that meet that following criteria:
  - Good condition, without any holes, dents, or other faults that might impair its proper containment. Do not place sharps in a LLRW bag. Radioactive sharps are managed as radioactive medical waste (see the Regulated Medical Waste Management Subject Area for definitions and procedures). When placing sharp-edged items in plastic radioactive waste bags or wrapping sharp-edged items in plastic, properly pad the edge in order to avoid compromising the plastic during packaging and transport.
  - Constructed from, or lined with, a material that is compatible with the radioactive waste to be stored.
  - For advice on container compatibility, see the Approved Containers exhibit.
  - Use a package that will ensure that the material will be contained and will prevent the spread of contamination during handling and transport.
- Drain all fluids from LLRW (e.g., vacuum pumps) prior to placement in package.
- For scintillation vials, follow these requirements:
  - Drain scintillation liquid from the vial so that no more than 1% of the liquid (by volume of vial) remains.
  - Place open, properly emptied vials in packages of compactible LLRW waste.
  - Complete a separate Radioactive Waste Inventory Form and a Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) for liquids.
- No free liquids can be in packages of solid waste.
  - **Exception:** Regulated radioactive asbestos waste (any waste that contains more than one percent asbestos by weight and that can be crumbled, pulverized, or reduced to powder when dry, by hand pressure) is permitted to have no more than one percent free liquid (one pint of liquid per standard-size bag).
- Provide secondary containment for all liquid radioactive wastes to hold 10% of total volume, or 100% of the volume of the largest container.

Waste generators must obtain approval from Waste Management (WM) when packaging noncompactible waste in any packaging or container other than yellow

	packaging noncompactible waste in any packaging or container other than yellow LLRW bags. Contact the Radioactive Waste Program Manager for additional guidance. **Note:** Keep radioactive waste containers closed at all times except when adding or removing waste. **Note:** The final waste package (e.g., B-12, B-25, or B-52) should have an even load distribution.
Step 4	Ensure there are no void spaces in packages of noncompactible solid LLRW that exceed two inches across or 10% of the total volume. If B-12, B-25, or B-52 containers are selected, the Radioactive Waste Accumulation Area Manager must assign a Container Custodian for each package. Container Custodians are responsible for the following: • Inspect packagings for deficiencies • Ensure all waste parcels added to packagings are included on the Radioactive Waste Inventory Form. • Maintain control over packagings while they are being filled and prior to closing for pick up and transport to an approved treatment, storage, or disposal facility (TSDF) or to WM. **Note:** The Container Custodian should contact their Supervisor or Radioactive Waste Program Manager if unsure of the type of packaging required for waste parcels.
Step 5	Maintain an inventory of the articles added to the waste container sufficient to characterize the waste for storage, shipment, and disposal.

	• Include the date, article description (i.e., type of metal, plastic, pump, target source, etc.), radionuclides, RWCF or ANMWCF number, weight, (i.e., curie, microcurie) of the waste item(s). **Note:** Keep the Radioactive Waste Inventory Form at or near the waste package (s)/container(s).
Step 6	If using Yellow LLRW Bag(s), seal with duct tape using a J-Seal for Bags. • Fill in the generator section on the Radioactive Waste Label and attach the label to the package(s). **Note:** The Radioactive Waste Control Form (RWCF)/Accountable Nuclear Material Waste Control Form (ANMWCF) should be completed at the time the LLRW bag, package or other container is sealed. Items that are not considered waste should not be stored in LLRW bags, packages, or containers intended for disposal or that have any waste markings on them.
Step 7	Ensure the Facility Support Representative or trained designee surveys the package(s) to verify that it meets the criteria in Table 2-2, Definition of Removable and Fixed Contamination Levels of the Radiological Control Manual Program Description. • Complete the radiological information section of the Radioactive Waste Label.

Guidelines

If a radioactive material is determined to have any intrinsic value before declaring it as waste, the following groups should be notified of the material's availability:

- Staff within your Department/Division;
- Staff outside your Department/Division (e.g., the Laboratory's Isotopes & Special Material Group or the Property & Procurement Management Division).

References

Radiological Control Manual Program Description

Regulated Medical Waste Management Subject Area

Training and Qualifications Web Site

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Subject Area: ***Radioactive Waste Management***

2. Completion of Radioactive Waste Control Forms

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to all waste generators.

Required Procedure

Step 1	Characterize the waste and complete the Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) as follows:
	
	• Describe the waste and the process that generated the waste.
	• List the physical/chemical components of the waste with the percentages by volume on the Radioactive Waste Inventory Form.
	• List the chemical components of the waste with the percentages by volume. Use the Material Safety Data Sheet (MSDS) Search to determine this.
	• List the radioactive isotopes and the activity in microcuries.
	    ○ Use the Radioactive Waste Inventory Form for guidance.
	    ○ You may determine the concentration of a radionuclide by either of the following methods:
	        ▪ **Direct methods**, such as gamma-ray spectroscopy, scintillation counter (H3), or Dose-Rate-to-Activity Conversion
	        ▪ **Indirect methods**, such as radionuclide material accountability (mass balance) or the use of scaling factors that relate the inferred concentration of one radionuclide to another that is measured, if there is reasonable assurance that the indirect methods can be correlated with actual measurements.
	• Note any Transuranic (TRU) radionuclide present in the waste in concentrations exceeding 1 nanocurie per gram (1nCi/g).
	• Report any radionuclide that accounts for more than 1% of the total radiological activity of the waste.
	• Select the analysis method used to determine activity and attach copies of all supporting characterization documentation.
	
	Note: If isotopic content is estimated based on mass, or if indirect methods were used to characterize the waste, the waste item(s) must be weighed and isotopic calculations and characterization methods used must be forwarded with the RWCF or ANMWCF.
	
	For characterization guidance refer to the exhibit Low-Level and Transuranic

	For characterization guidance refer to the exhibit Low-Level and Transuranic Waste Generator Characterization Guidance, or contact your Waste Management Representative for assistance. If the Toxicity Characteristic Leaching Procedure (TCLP) is required on your waste item or stream, include elemental zinc. **Note:** Any special hazards on the "Precautions" line (e.g., shards of glass, highly radioactive [greater than or equal to100 μR/hr contact], etc.).
Step 2	Identify the quantity of waste, including the following items: • Use one Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) for each package. • Describe the package type (e.g., plastic bag, B-25 bin). • Provide the volume of the waste **only** (gallons for liquids, cubic feet for solids) and the weight of waste **only** (in pounds) in the package. **Note:** Report specific waste weight for high activity items such as sources, and/or accountable nuclear material (i.e., if the actual weight is less than 1 lb., record the weight in grams or to the nearest one hundredth of a pound on the RWCF).
Step 3	On the Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF), clearly print the following information: • Generator; • BNL extension; • Life Number; • Department/Division responsible for generating the waste; • Account number for waste disposal; • The accumulation area building number, and • The date that the waste was placed into the 90-Day Accumulation Area.
Step 4	Transfer the RWCF or ANMWCF number onto the Radioactive Waste Label and the Radioactive Waste Inventory Form and attach the forms to the characterization documentation.
Step 5	Ensure the Facility Support Representative surveys and smears the waste container, and complete the "For Facility Support" section of the RWCF or ANMWCF prior to submitting to Waste Management for review and approval. • Waste containers must be free of outside contamination. • The surveyor is required to sign, provide their life number, and date the RWCF or ANMWCF. • The surveyor must transfer survey information onto the Radioactive Waste Label.
Step 6	Review, sign, and date the certification statement.
Step 7	Submit the RWCF or ANMWCF and supporting characterization documentation to the Radioactive Waste Accumulation Manager.
Step 8	Notify the Radioactive Waste Accumulation Manager prior to placement of waste into the area.
Step 9	Ensure the waste is moved to the Radioactive Waste Accumulation Area.

	Note: Complete a Radioactive Waste Inventory Form, RWCF, or ANMWCF for the item before placing waste in the Radioactive Waste Accumulation Area.

Guidelines

Staff should use only permanent, blue or black ink when completing waste control forms.

Staff should use information on the Radioactive Waste Inventory Form to complete the Radioactive Waste Control Form or Accountable Nuclear Material Waste Control Form.

References

Material Safety Data Sheet (MSDS) Search, Chemical Management System web site (*Limited Access)

*Access Limited to BNL Staff and Authorized non-BNL Staff

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Subject Area: ***Radioactive Waste Management***

3. Establishing a Radioactive Waste Accumulation Area

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to Radioactive Waste Accumulation Area Managers.

Required Procedure

Step 1	Ensure your training status as a generator of radioactive waste is up-to-date. • To ensure you are within the two-year qualification period for the HP-RADIGEN (Radioactive Waste Generator) course, consult the Training and Qualifications Web Site or contact your Department/Division's Training Coordinator. • If your training is not current, then attend training in the proper methods for handling, documenting, and disposing of radioactive waste. For additional information on training requirements, contact the Radioactive Waste Program Manager.
Step 2	Register the area with Waste Management by completing the Radioactive Waste Accumulation Area Registration Form.
Step 3	Dedicate a separate area for the collection of radioactive waste and ensure its segregation from nonradioactive waste by posting the area, or erecting/using a physical barrier (refer to the Example of a Well-Maintained Radioactive Waste Accumulation Area exhibit). • Locate the area to protect the accumulated waste from damage due to weather (e.g., protection from temperature extremes). • Areas must accommodate material handling equipment and must have unobstructed access for inspections and waste pickups. **Note:** Waste area(s) must be segregated by classification (i.e., Decay in Storage, LLLRW, Mixed).
Step 4	Post the Radioactive Waste Accumulation Area Basic Rules Sign and Prohibited Articles in Radioactive Solid Waste Packages sign at or near the accumulation area.

References

Training and Qualifications Web Site

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Subject Area: ***Radioactive Waste Management***

4. Operating a Radioactive Waste Accumulation Area

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to Radioactive Waste Accumulation Area Managers.

Required Procedure

Step 1	Ensure the Radioactive Waste Inventory Form, Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) has been completed for all waste in the Radioactive Waste Accumulation Area.
Step 2	Submit the Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) and supporting characterization documentation (e.g., inventory form, MSDS, analytical report, calculation, or indirect characterization methods) to Waste Management (WM) for review and approval of waste pickup. • Maintain copies of all waste control forms that document the wastes staged in the Radioactive Waste Accumulation Area until the waste is picked up by WM. **Note:** If the waste control form is not filled out correctly; if the waste generator has not received proper training; or supporting characterization documentation has not been forwarded, WM will contact the generator and request additional information or return copies of the waste control form along with an Incomplete Waste Control Form Notice, which prescribes the action to be taken, to the generator and the Radioactive Waste Accumulation Area Manager.
Step 3	Waste Management schedules the wastes for pickup within 90 days of the RWCF or ANMWCF being approved by WM. • If Waste Management personnel are unable to locate the waste scheduled for pickup, the Radioactive Waste Accumulation Area Manager is notified and reschedules the pickup. • The rescheduled waste pick-up should not lead to waste being staged for >90 days.

	Note: If waste has been staged for >90 days, generators or Radioactive Waste Accumulation Area Managers should contact the Radioactive Waste Program Manager for immediate pickup.
Step 4	Ensure packages/containers are tightly sealed prior to transporting waste. • Handle and store waste containers to prevent leakage or spillage of the contents. • Containers are not to be stored in an environment that will promote the freezing of the contents. • Containers are not to be left either partially or fully blocking aisles or other access ways. • Containers are not to be stored where the potential exists for leakage to enter sinks or drains. • Containers are to remain in good condition, without holes, dents, or other faults.
Step 5	Provide secondary containment for all liquid radioactive wastes. • Secondary containment must be sufficient to hold 10% of the total volume [30% if total volume is greater than 250 gallons (33.5 cubic feet or 950 liters)] **or** 100% of the volume of the largest container to be stored, whichever is greater. • All sinks and floor drains in the vicinity must be plugged to prevent possible spillage from entering the building's sanitary sewage system. • Tilt or otherwise design the base of the secondary containment to drain and remove liquids resulting from leaks and spills **or** elevate the waste containers to protect them from contact with spilled liquids. Refer to the Spill Response Subject Area for spill-response requirements and notifications. Maintain spill-control equipment appropriate for the type of waste stored in the area.
Step 7	Inspect the area monthly by completing the approved Radioactive Waste Accumulation Area Monthly Inspection Checklist. • Retain inspection checklists outside the area (but readily accessible) in accordance with the Records Management Subject Area or the Department/Division's record retention procedures for radioactive material.

Guidelines

In accordance with DOE Order 435.1, *Radioactive Waste Management*, as implemented by the DOE-approved Radioactive Waste Management Basis (RWMB) for Brookhaven National Laboratory in the Radioactive Waste Management Basis Program Description, routine radioactive waste may not be staged in generator facilities more than 90 days after the Radioactive Waste Control Form is approved by Waste Management for pickup.

The area should be informally inspected on a weekly basis.

References

DOE Order 435.1, *Radioactive Waste Management*

Radioactive Waste Management Basis Program Description

Records Management Subject Area

Spill Response Subject Area

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Subject Area: ***Radioactive Waste Management***

5. Decay in Storage

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to all waste generators.

Required Procedure

Step 1	Segregate radioactive waste that is to be handled by Decay in Storage (DIS) by isotope at the point of generation. - Consult the Radionuclides Eligible for Decay in Storage exhibit for commonly used short half-life radionuclides, their half-lives, and the ten half-life decay period. - Isotopes with half-lives of less than 90 days that are not listed on the table are also eligible for DIS. - Wastes with very short half-lives (i.e., those that would complete the ten half-life decay period overnight) may be decayed at the point of generation.
Step 2	Mark containers holding DIS waste with the following information: - Contents; - Generator name; - Isotope and activity (microcuries); - Half-life; - Date of last addition of waste; - Date of the end of the ten half-life decay period (the earliest date the waste will be eligible for disposal); calculate this date by multiplying the half-life of the isotope by ten and adding that time period to the date the last waste was added to the container.
Step 3	Ensure each package of DIS waste is surveyed for external radiation and smeared for contamination. - If the material is liquid or powder, analyze a representative sample to determine the presence of radioactive material. The survey must be documented and traceable to the DIS waste package. - Wastes such as non-sampleable solids (e.g., disposable clothing, blotting paper, etc.) require only the external and smear survey.
Step 4	In addition to the other requirements cited here, release DIS waste decayed at the point of generation for disposal only after all of the following criteria have been met:

	• The waste has decayed for a minimum of ten half-lives, **and** • The radiological survey and/or analysis has determined that the radioactivity of the waste cannot be distinguished from the background radiation level when surveyed in an area where background is less than 13 μR/hr (and the contamination check, if required, is also negative). • Contact the Radioactive Waste Program Manager for approved means of disposal.
Step 5	Complete a Decay in Storage (DIS) Record of each disposal.
Step 6	Retain records of DIS waste in accordance with the Records Management Subject Area.

References

Records Management Subject Area

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Subject Area: ***Radioactive Waste Management***

6. Waste Certification

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to all waste generators.

Required Procedure

DOE Order 435.1 requires the development, review, approval, and implementation of waste acceptance requirements for facilities that receive radioactive waste for storage, treatment, or disposal. Radioactive waste acceptance requirements establish the facility's requirements for the receipt, evaluation, and acceptance of waste. DOE Order 435.1 also requires radioactive waste generators to implement a program to address the characterization of waste; preparation of waste for transfer; certification that waste meets the receiving facility's radioactive waste acceptance requirements; and transfer of waste. This requirement for the certification of radioactive waste to the receiving facility's waste acceptance requirements applies both to the on-site transfer of waste from the BNL generator's facility to Waste Management (WM) facilities, as well as the transfer of waste to off-site treatment, storage, and disposal facilities (TSDFs).

For on-site waste transfers, radioactive waste acceptance requirements are defined by the administrative, characterization, waste form, and packaging requirements defined within this subject area. The BNL waste generator's signature on the Radioactive Waste Control Form (RWCF)/Accountable Nuclear Material Waste Control Form (ANMWCF) represents the generator's certification statement that the waste meets the subject area requirements.

Only WM can certify BNL radioactive wastes prior to off-site transfer to TSDFs. Waste certification is the process performed by WM affirming that a given waste or waste stream meets the waste acceptance criteria of the off-site TSDF to which the waste will be transferred, in accordance with the requirements of the BNL Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description. The WM Program maintains waste stream profiles for approved off-site TSDFs.

Step 1	Follow all procedures in this subject area to ensure radioactive wastes are properly managed and transferred to WM for waste certification and final

	properly managed and transferred to WM for waste certification and final disposition. **Note:** Use of non-DOE disposal facilities requires DOE approval of an exemption request. See Appendix A - Request for Use of Non-DOE Facility for Disposal of Radioactive Waste in the Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description.

References

Radioactive Waste Management Basis Program Description

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Subject Area: ***Radioactive Waste Management***

7. Processing Radioactive Liquid Waste

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Applicability

This information applies to all radioactive liquid waste generators.

Required Procedure

DOE Order 435.1, *Radioactive Waste Management*, requires liquid radioactive waste generators to implement a program to address the characterization, storage, and certification that liquid waste meets the receiving facility's waste acceptance criteria. This radioactive liquid waste processing criteria defines requirements to meet waste stream characterization and waste acceptance criteria (WAC) for storage and transfer of Liquid Low-Level Radioactive Waste (LLLRW).

Contingency storage is required for activities that involve the storage of high-hazard or high-activity LLLRW. For off-normal or emergency situations, spare capacity with adequate capabilities must be maintained to receive the largest volume of liquid contained in any one storage tank (i.e., if LLLRW is stored in two storage tanks with a capacity of 500 gallons each and the waste has the same chemical and radiological characteristics, a spare capacity of 500 gallons must be available to satisfy contingency storage requirements). In addition, transfer equipment (i.e., pipelines, pumps, valves) necessary to transfer the contents of each tank should be tested and inspected as part of a routine maintenance program. Waste Management maintains contingency storage capabilities for the BNL complex. Contact the Radioactive Waste Program Manager for further guidance.

Waste characterization is the process performed by the radioactive liquid waste generator affirming that a given liquid waste or waste stream meets the waste acceptance criteria within this subject area and in accordance with the Liquid Waste Tank Mixing and Drum Sampling Guidance Document.

Step 1	Collect Liquid Low-Level Radioactive Waste (LLLRW) in drums, high integrity containers (HICs), or storage tanks. **Note:** Containers should be in good condition, without any holes, dents, or other

	Note: Containers should be in good condition, without any holes, dents, or other faults that might impair its proper containment. Refer to the Storage and Transfer of Hazardous and Nonhazardous Materials Subject Area.
Step 2	Provide secondary containment for all liquid radioactive wastes to hold 10% of total volume, or 100% of the volume of the largest container.
Step 3	When containers are full or ready for transfer, sample and characterize the radioactive liquid waste. **Note:** Refer to the exhibit Liquid Waste Tank Mixing and Drum Sampling Guidance Document for examples of protocols used.
Step 4	When characterization of the LLLRW is complete, refer to the waste acceptance criteria below to determine if LLLRW is managed as hazardous or mixed waste.
Step 5	Complete a Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) in accordance with the section Completion of Radioactive Waste Control Forms. **Note:** LLLRW, which does not meet the waste acceptance criteria (WAC) below and requires additional handling or alternative processing, will be managed at the Waste Management facility.

Waste Acceptance Criteria

General Limits

pH Range	5 - 9
Solids Content	<5% by Volume
Oil Content	<1% by volume
Chelating Agents	<1% by volume
No Etiological Agents	
No Biological Waste	

RCRA/TSCA Limits

No listed wastes (F, K, U, P)
No characteristic wastes

Toxic Metals (40 CFR 261.24) - Toxicity Characteristic Leaching Procedure (TCLP)

Arsenic	<5.0 mg/L (ppm)
Barium	<100.0 mg/L
Cadmium	<1.0 mg/L
Chromium	<5.0 mg/L
Lead	<5.0 mg/L
Mercury	<0.2 mg/L
Selenium	<1.0 mg/L
Silver	<5.0 mg/L

Organics

See list of organic compounds and their respective regulatory levels listed in 40 CFR 261.24. Any compound, which cannot be certified by the generator to be absent from the liquid, must

Any compound, which cannot be certified by the generator to be absent from the liquid, must be tested for using TCLP standards.

PCB=s	<5 ppm
Flashpoint	>141 F

Radiological Limits

Radiation Levels

Wastewater that is collected and will be stored in the aboveground storage tanks at Building 810/811 (via drum[s], tanker truck, or other Waste Management vessel) is limited to the following:

Radiation Level <100 mRem/hr at contact with vessel wall prior to transfer to water processing facilities

Removable External Contamination (when packaged) <1,000 dpm/100 cm2

Radionuclide Limits

Radiological Facility Threshold limits (below the DOE-STD-1027-92, Nuclear Hazard Category 3 limits)	
Transuranics	(e.g., alpha-emitting nuclides, Am241, Cm, Ra226) less than 100 nCi/g.

Other Requirements for Generators of Wastewater

An approved Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) must be submitted prior to waste acceptance at any WM facility (including pickups or deliveries to Buildings 802, 810, and 811).

Generators may be required to have an alpha spectroscopy analysis performed to determine the presence of Transuranic (TRU) or Special Nuclear Materials (SNM).

If human waste, organic compounds, or other hazardous materials are suspected to be in the waste, generators may be required to perform an additional analysis.

Leaking or damaged containers will not be accepted.

Generators that store and transfer radioactive waste should refer to the Storage and Transfer of Hazardous and Nonhazardous Materials Subject Area for additional requirements.

Generators (Departments/Divisions) that generate more than 1,000 gallons per year will forecast all wastewater volumes annually. Forecast information from generators should include the following, as a minimum:

- Estimated total volume of wastewater to be generated (for the year):
  - Number of expected transfers (or separate containers)
  - Volume per transfer or container, in gallons
- Activity that generated the waste;
- Type of package or container (tanker truck, drum, vial, etc.);
- Dates and locations of each waste stream being generated;

- Anticipated schedule for transfers to Waste Management (WM);
- Estimated activity and concentration for primary isotopes;
- Anticipated dose rate of each transfer or container (use highest value);
- Estimated tritium content.

References

40 CFR 261, Identification and Listing of Hazardous Waste

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques*

DOE Order 435.1, *Radioactive Waste Management*

Storage and Transfer of Hazardous and Nonhazardous Materials Subject Area

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Subject Area: ***Radioactive Waste Management***

Approved Containers *

Effective Date: **December 2000**

Point of Contact: Radioactive Waste Program Manager

Waste Type	Translucent Yellow Plastic Bag	Sealable Container Compatible With Waste	Special Packaging Call WMD
Compactible Low Level Radioactive Waste (LLRW)	X		
Noncompactible LLRW	X		X
Activated Metals			X
Liquid LLRW		X	

* If waste is not suitable for package identified above, contact the Environmental Subject Matter Expert on Radioactive Waste Management or the Operations Supervisor.

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3.0-122000/standard/0h/0h01e011.htm

Subject Area: ***Radioactive Waste Management***

Example of a Well-Maintained Radioactive Waste Accumulation Area

Effective Date: **December 2000**

Point of Contact: Radioactive Waste Program Manager

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3.0-122000/standard/0h/0h12e011.htm
1.0-061999/standard/0h/0h12e011.jpg

Send a question or comment to the SBMS Help Desk

Subject Area: ***Radioactive Waste Management***

J-Seal for Bags

Effective Date: **December 2000**
Point of Contact: Radioactive Waste Program Manager

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The only official copy of this file is the one online in SBMS. Before using a printed copy, verify that it is the most current version by checking the document effective date on the BNL SBMS website.

3.0-122000/standard/0h/0h02e011.htm
1.0-061999/standard/0h/0h02e011.jpg

Send a question or comment to the SBMS Help Desk

PROHIBITED ARTICLES IN RADIOACTIVE SOLID WASTE PACKAGES, (LLW), (compactible and noncompactible)

revised 12/2001

- **Incandescent and Fluorescent Light Bulbs**, flashlight, drop lights, and floodlights
- **Batteries**, flashlight/beeper dry cells and emergency light batteries
- **Lead**, bricks, sheets, fuses, printed circuit boards, computer monitors, televisions, bronze strainers/floor drains/fittings, brass sand-cast elbow/valves, items that would fail TCLP** (i.e., compounds not otherwise specified [NOS])
- **Liquids**, any amount of unabsorbed, nonregulated free liquids (unless asbestos waste 1% free - OK) - sorbent must be added to all final packaging with condensation potential.
- **Aerosol Cans**, **see pollution prevention initiative (e.g., pressurized containers that include aerosol cans, fire extinguishers, and lecture bottles)
- **Mercury**, thermostats, relays, thermometers, and compounds NOS
- **Unauthorized Chemicals/Solvents**, **contact your WMR
- **Combo Respirator Cartridges**, where combos are, mixed wastes exists, there are some combos regulated just by the reagents within them (e.g., ammonia) **
- **Syringes, scalpels, hypodermic needles**, even if nonmedical application**
- **Dismantled circuit boards**, may contain hazardous materials**
- **Drager/Sensodyne tubes**, may contain hazardous materials**
- **Animal waste/animal carcasses**
- **Green or wet vegetation**
- **Oils, fuels, and other organic liquids**, even if absorbed into solid

Note: Each bulleted item is a separate and distinct waste and should be packaged/labeled accordingly **.

Questions/path forward for prohibited articles/items considered mixed or State regulated - **ask your Waste Management Representative, or contact the Radioactive Waste Program Manager **or** Mixed Waste Program Manager**.**

LIQUID WASTE
TANK MIXING AND DRUM SAMPLING
GUIDANCE DOCUMENT

Characterization of containerized liquid wastes for proper disposal is the means by which the waste generator, Brookhaven National Laboratory (BNL), samples and quantifies the contaminants in a liquid waste stream. This plan provides BNL guidance on the obtaining a representative sample of containerized liquid, the needed documentation, and the approvals needed to complete the containerized liquid waste characterization process.

The objectives of tank mixing and drum sampling are to ensure:

- ***safe waste handling and environmental protection, and***
- ***materials are properly characterized and classified through the use of representative samples.***

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1.0 APPLICABILITY

This guidance is applicable to bulk containerized liquid waste streams that are disposed offsite, generated as a result of environmental restoration or other activities at BNL. A bulk liquid waste stream is generally one where a relatively large quantity of similar waste has been generated and is being managed in bulk. This guidance is applicable to the following liquid waste streams:

- Bulk liquids, non-aqueous liquids, and phase-separated liquid organics,
- Low Level Radioactive Waste (LLRW),
- Mixed waste streams contaminated with LLW and RCRA hazardous waste,
- Resource Conservation and Recovery Act (RCRA) hazardous waste (as defined by 40 CFR 261),
- TSCA waste (such as PCBs), and
- Any combination of the materials listed above.

Even though the waste characterization methods in this guidance may be valid, in whole or in part, for the following waste streams, wastes containing any of the following materials do not fall under this guidance document and should be evaluated on a case-by-case basis. Additional guidance for sampling and characterizing these types of waste can be found under the BNL Standards-Based Management System (SBMS) Subject Areas for hazardous, radioactive, and mixed waste:

- Solids, semi-solids, gaseous, and non-containerized liquids,
- Pyrophorics and materials subject to spontaneous combustion,
- DOT forbidden Class 1.1, 1.2, and 1.3 explosives and shock sensitive material,
- High alpha-content wastes exceeding 100 nanocuries per gram of transuranic radioactivity, and
- Non-empty compressed gas cylinders.

The sampling guidance is based on the conditions that the waste stream has been generated with sufficient process knowledge so the primary objective is to obtain a representative sample, particularly in the case where different waste streams are bulked into a single stream for disposal or where stratified wastes are sampled.

2.0 GLOSSARY OF TERMS

Bulk Liquid Waste - Waste that contains mostly free liquids, generated by a process that results in relatively large quantities of similar waste. Liquid waste can contain a substantial volume of sludge or suspended solids. Smaller volumes of liquid waste can be managed under the BNL Standard Base Management System (SBMS) Subject Areas for hazardous, radioactive, and mixed waste.

COLIWASA - Composite Liquid Waste Sampler - Device for obtaining samples of stratified or unstratified liquid from containers such as tanks or drums. It consists of a long tube with a stopper on the bottom and locking mechanism on the top to obtain a liquid sample at a specified depth.

Composite Sample – A sample composed of more than one individual sample collected from more than one sampling location or depth and mixed thoroughly before analysis.

Contaminants of Concern (COCs) – List of contaminants whose concentrations in the waste approach or exceed some threshold of interest (such as an action level, acceptance criteria, or regulatory threshold) and whose measurements will form the basis of the waste characterization decisions.

Hazardous Waste – Constituent in a solid waste that is specifically listed in RCRA 40 CFR 261 or has characteristics defined therein or listed in equivalent state definitions.

High Integrity Containers (HIC) - Temporary, portable tanks that are constructed with double walls so as to be exempt from the requirements of secondary containment.

Hot Spot – An area within the waste that exhibits significantly higher concentrations of contaminants of concern (chemical and/or radiological) than the majority of the waste volume.

Low-Level Waste (LLW) – In general, LLW is radioactive waste that is not classified as Spent Nuclear Fuel, High-Level Waste, or Transuranic Waste, or by-product materials such as mill tailings. The classification is based on DOE Order 5820.2A for DOE legacy waste.

Mean Concentration of Samples ($\bar{x}$) – Sum of the measured concentrations of a COC in a series of samples divided by the number of measurements, used to estimate true population mean.

Mean Concentration of Population (μ) – The true average concentration in the waste population that is being estimated by using the mean concentration of the samples.

PCB TSCA Waste – Any PCB article or container whose surface has been in direct contact with PCBs$\geq$50 ppm and that exhibits PCB concentrations $\geq$500 ppm or any PCB item (including soil) that contains PCBs at concentrations >50 ppm is considered a TSCA waste according to 40 CFR 761.1-.80.

Polychlorinated Biphenyls (PCBs) – Substances commonly found in older capacitors, transformers, light ballasts, electrical equipment, or hydraulic equipment and oils that were used for their heat exchange properties and are regulated under the Toxic Substance Control Act.

RCRA Hazardous Waste – Any waste listed in 40 CFR 261.33 or a waste that exhibits hazardous waste characteristics.

RCRA Hazardous Waste Characteristics – The characteristics of ignitability, corrosivity, reactivity, and toxicity as defined in 40 CFR 261.21-23, a demonstration of which results in the waste being classified as hazardous.

Regulated Waste - A waste that is subject to RCRA hazardous waste or TSCA PCB waste management and/or spill cleanup regulations. This concept also can be applied to classify waste for purposes of transportation under DOT regulations.

Regulatory Threshold - The numerical value established by RCRA and TSCA regulations that represents the concentration of a COC in a waste that is used to determine whether a waste is regulated or non-regulated based on that COC concentration.

Resource Conservation and Recovery Act (RCRA) – Statute that is supported by a body of regulations that govern the generation, transport, and disposal of hazardous waste.

Stratified Waste – Waste that exhibits non-random variations in its physical and/or chemical characteristics either spatially or over time.

Subsampling – The process of subdividing a field sample into representative parts for placement into various sample containers needed to perform a range of analytical tests.

Standard Deviation (s) – A term that represents the variability in a normally distributed sample population. Standard deviation represents the sample variability due to the range of concentrations in the waste, errors during sampling, and errors during laboratory analysis.

Toxic Substance Control Act (TSCA) – Statute that is supported by regulations that govern the generation, transport, disposal, and cleanup of polychlorinated biphenyls (PCBs).

Waste Acceptance Criteria (WAC) – A list of waste constituents and associated concentrations which limit the type and concentrations of waste that a facility can accept for disposal and continue to comply with the requirements of their permit to operate.

3.0 LIQUID WASTE CHARACTERIZATION

One purpose of this guidance is to help the sampler make the decision whether or not to blend his or her bulk liquid waste prior to sampling, when to sample from tanks, and how to obtain a representative sample from 55-gallon drums of liquid wastes. If the decision to blend or mix the waste is made, this document provides guidance on the best approach for achieving the mixing required to obtain a representative sample of the waste. Depending on what is known about the waste, some chemical or radiological screening may be necessary to provide a basis for sampling and characterization.

3.1 Screening for Waste Characterization

Screening waste samples is particularly useful when existing data are insufficient to characterize the waste constituents for disposal or classification. Screening is a relatively inexpensive way to obtain a general idea of the waste constituents without sending samples to the laboratory for detailed analysis. Screening bulk liquid wastes should be undertaken only when process knowledge or existing characterization data are not sufficient to make waste determination decisions.

Screening methods for preliminary waste characterization can be implemented in the field or laboratory and can provide either quantitative or semi-quantitative results. Field screening methods are generally faster and less costly than laboratory analyses, but may be less sensitive and employ less quality control. However, they allow field personnel to define problem areas quickly and to guide sampling and verification analysis.

3.2 Considerations for Homogeneous Wastes

A homogeneous waste stream is one that does not vary over time or space. With a uniform waste, the average sample contaminant concentration ($\bar{x}$) is very nearly the true concentration in the waste (μ) and the standard deviation (***s***) is small. There may be some cases when the sampling performed on a homogeneous waste may not accurately represent the composition of the waste when it arrives at the disposal facility. Homogeneous wastes may become heterogeneous after they are stored and transported for disposal as a result of settling, heating and cooling cycles, or vibration during transport. These changes may be particularly true of wastes that contain suspended solids, volatile organic compounds (vapors may accumulate in the head space of shipping containers), or compounds that transform into other compounds through chemical reactions during storage. It should be noted that these conditions also can exist for heterogeneous wastes. In these cases, the disposal facility shall be notified ahead of time that this stratification might occur and their verification sampling should take these transformations into account.

3.3 Considerations for Heterogeneous Wastes

Heterogeneous wastes at BNL can be generated in two major ways - either the wastes consist of two or more components that do not have similar characteristics (such as non-aqueous and aqueous phase liquids) or an unanticipated or unusual waste with a significantly different characteristic occasionally enters the larger stream. Either of these occurrences requires special consideration when designing a waste management program.

One way a representative sample of a stratified waste can be obtained is by the thorough mixing of the different components into a uniform waste. The waste can be represented by a relatively few number of samples which should have similar characteristics. Blending is recommended if it can incorporate the higher contamination into the less contaminated bulk waste, so the average concentrations in the waste are below the WAC or some other threshold[1].

Another alternative is to sample and manage the different components as separate populations. This is recommended if:

1) A portion of the waste is much more contaminated than another portion,
2) The portions can be easily separated and sampled, or
3) Mixing would cause the entire waste stream to managed as strictly as the highly contaminated portion.

If the highly contaminated waste can be separated from the less contaminated waste, the less contaminated waste may be able to meet more restrictive treatment or disposal requirements and be less expensive to manage.

Whether or not a waste should be mixed prior to sampling is a management decision that should be made by the WMD and the sampling team leader. This decision shall be made prior to waste generation, if possible. The limitations of mixing are discussed later in this guidance document.

3.4 Sampling for Pre-Shipment Waste Profiling

Many treatment, storage, and disposal facilities (TSDFs) require pre-shipment profiling to establish whether a waste stream is generally acceptable at their facility. The purpose of pre-shipment waste profiling is to bracket the possible high and low concentrations in the shipment, while still accurately representing the conditions of the waste stream. The pre-shipment analytical results are not used by the TSDF for making a final decision to accept or reject a waste, but to estimate the constituents in a waste stream for planning purposes (such as whether a waste stream is likely to need treatment to meet the Land Disposal Restrictions - LDRs). Therefore, the range of COCs quantified in the pre-shipment sample generally is used, along with subsequent sampling, to verify that the correct shipment has been sent. TSDFs sample waste shipments as they arrive and compare the results to the pre-shipment profiles.

It is critical that the sample results fall within the brackets of the waste profile. If the sampling performed on waste as it arrives at the TSDF does not fall within the range of expected values established in the pre-shipment profile, even if the concentrations meet the WAC, the waste may undergo additional scrutiny and may be rejected.

To reduce the likelihood of a discrepancy, BNL personnel shall collect samples for pre-shipment in a manner that <u>maximizes</u> the range of values in the pre-shipment sample while still demonstrating WAC compliance. The goal of this sampling is to provide “worst case” results, to ensure that the disposal

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[1] RCRA, DOE, and TSCA regulations generally prohibit mixing waste that does not exceed a regulatory threshold with waste that does in order to render it non-regulated (i.e., you cannot dilute a waste to avoid regulation). However, mixing waste that exceeds the WAC with that which is below the WAC for the purposes of creating a waste whose average concentration falls below the WAC is not prohibited, as long as the mixing does not affect its RCRA, DOE, or TSCA classification.

facility will not reject a shipment, no matter how they collect their samples. Biased sampling for pre-shipment should be performed "authoritatively", without regard to randomness. Several samples shall be collected from visible stratification layers or from areas where the highest concentrations are suspected for pre-shipment profiling. A different strategy will be applied to collecting samples for waste characterization and classification, where samples that represent the average characteristics of the waste stream are desired.

3.5 Designing the Sampling Scheme

This guidance does not include a discussion of how to design sampling to obtain a representative sample of the waste. However, in general, deciding on the appropriate sample type or scheme for waste characterization or classification shall be based on the physical, radiological, and chemical characteristics of the waste. An appropriate sampling design shall be selected to provide sufficient accuracy[2] and precision[3] to characterize the waste for disposal. Sample accuracy is usually achieved by incorporating randomness into the sampling design, while precision is improved by increasing the number or size of the samples. Table 1 summarizes the available sampling schemes and the advantages and limitations of each. Sampling bulk liquid wastes for pre-shipment profiling may employ a variety of schemes, but sampling bulk liquid waste for characterization generally uses authoritative sampling conducted from a sampling port in the container.

4.0 BLENDING AND SAMPLING PROTOCOLS FOR STORAGE TANKS

Waste tanks at BNL generally contain liquid from laboratory or waste management operations. They can include RCRA hazardous, TSCA-regulated, petroleum, low level, or mixed wastes. One objective of these guidelines is to establish operating conditions and times for successful blending of the contents in waste storage tanks before sampling, and how to make the decision whether to blend the contents or not. This guidance specifically addresses liquid waste in three 500-gallon tanks in Building 801 that contain D-waste (low level radioactive waste mixed with water) the 24,000-gallon waste tank managed by WM, and the high integrity containers (HICs) that are sometimes used for temporary storage, but may be applicable to other tanks with similar wastes.

4.1 Decision to Blend or Not

Thorough mixing of the waste prior to sampling is not always desirable, necessary, or possible. The decision whether to blend the contents of a container before sampling depends on the characteristics of the container, the objectives of the sampling program, and the nature of the waste. Small containers, such as 55-gallons drums, can be easily sampled using composite samplers, such as Coliwasa tubes, that take a fully integrated sample of all layers of the waste, but this is more difficult to do in large tanks. When the entire vertical column of waste can be sampled, it is not necessary to mix the contents to obtain a representative sample.

As a general rule, do <u>not</u> mix or blend the waste in tanks under the following conditions:

- The work plan specifies the waste not be mixed before sampling.

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[2] Sampling accuracy is a measure of the closeness of a sample value to its true value (μ).
[3] Sampling precision is the measure of the closeness of repeated values to each other.

- Mixing the waste will create an unnecessary safety problem.
- Volatile organic compounds will be lost during mixing.
- The sampling device cannot collect all layers of concern, including a thin layer of solids at the bottom of the container, if it exists.
- Numerous discrete samples will be taken or samples will be composited while sampling.
- Mixing could introduce possible contamination into the container.
- Sampling during filling eliminates the need for additional mixing.

Table 1. Summary of Sampling Schemes

Sampling Scheme	Applicability	Description	Benefits	Limitations
Authoritative (Grab Sampling)	Use when extremely familiar with the waste characteristics and contaminant distribution, most appropriate for homogeneous waste	Sample is collected without regard to randomness, often based on visual evidence	Inexpensive and quick, provides valid results for homogeneous waste or when preliminary results are needed	Is not representative, does not quantify contaminant range or locate hot spots, usually not appropriate for waste characterization
Simple Random	Use when little or no information is available about the waste, when waste is thought to be randomly heterogeneous (default sampling design)	Divide waste into imaginary grid, assign a series of random consecutive numbers to the units, sample based on random number generation	Achieves sampling accuracy and precision when little is know about the waste	Poor accuracy and precision when trends or cycles in population are not recognized, complex sampling design
Systematic Random	Use when waste is randomly heterogeneous or only slight stratification is present	First unit to be sampled is randomly selected, but all others are taken at fixed time or space intervals	Easy sample design and collection	Poor accuracy and precision when trends or cycles in population are not recognized
Stratified Random	Use when waste is stratified or varies non-randomly over time or location, identifies hot spots	Numerically identify all strata and randomly sample each stratum	Will accurately reflect variability of waste and identify hot spots	Complicated sample design and collection, some prior knowledge about waste is necessary
Composite	Use when waste is only slightly variable and cost of sampling is significant compared to cost of mis-characterizing	Combine a number of random samples into finite composite samples	Larger sample increases precision, can sample more waste for smaller cost	Decreases sampling accuracy, masks sample variability, makes Type II errors more likely
Continuous Field Screening	Use when continuous reading instruments can be used to measure variability and identify hot spots during waste handling	Field instruments take continuous readings during waste handling, alarms set to sound when certain thresholds are exceeded	Sample variability and hot spots easily detected, inexpensive and rapid, can be used to make immediate field decisions	Not all constituents conducive to screening in the field, screening generally less accurate than laboratory analyses, may have to use surrogate species or total gross measurements

4.2 Objectives and Significance

Two different types of storage tanks were investigated for specific conditions related to blending. The smaller tanks have a nominal volume of 500 gallons and are agitated by air sparging. The larger tank has a nominal volume of 24,000 gallons and uses a recirculation pump to mix the contents. HICs were not sufficiently defined in terms of typical dimensions or mixing methods to offer definitive recommendations.

The waste tanks associated with Building 801 consist of three 500-gallon, stainless steel vessels. Two are actively used and one is a contingency tank. These tanks replaced old ones that had been in use for over 50 years, although the old piping has been retained. Waste in these tanks is generated by irradiating targets and by chemical processing of radioactive materials. It comes from discharges to sinks and from hot cells. The liquids consist primarily of acidic water contaminated with radionuclides, salts, and minor amounts of suspended solids (assumed to be from scaling in the old piping). The tanks are equipped with a pipe that introduces pressurized air to the bottom of the tanks used to mix the waste prior to sampling for disposal.

The 24,000-gallon tank contains water contaminated with various radionuclides, primarily tritium. The tank is generally less than half full. Approximately 20,000 gallons of waste is shipped out for treatment or disposal annually in quarterly, six to seven thousand gallon lots. The tank is nominally 38 feet long and 10 feet high and is configured like a horizontal cylinder. A 50 to 60 gallon per minute (gpm) pump brings waste into the tank, generally 350 to 450 gallons at a time roughly once a month.

4.3 Five Hundred Gallon Tank Blending

To guide the evaluation of the blending requirements in the 500-gallon tanks, an approximately to-scale sketch, such as the one shown in Figure 1, was used. The tanks can be filled to within roughly six inches of the top. To allow room for an effective liquid volume when air is sparged for agitation, the working volume should be limited to 450 gallons. Volume and liquid calculations are shown in Table 2.

Airflow rates are based on “superficial gas velocity.” The superficial velocity is the velocity of the gas if it were evenly distributed across the open cross-section of the tank. This velocity is not a real characteristic of the system, but an effective representation of the hydrodynamics of dispersion. The minimum and maximum air rates are based on superficial gas velocities of 0.01 and 0.1 feet per second (ft/s). The most practical and effective gas rates are at the lower end of this range, consequently the recommendation for 10 to 25 cubic feet per minute (cfm) gas rates.

The 500-gallon tanks should be agitated by an airflow rate of 10 to 25 cfm for about one hour for adequate mixing to occur. Airflow rates anywhere between 7.5 to 75 cfm should provide adequate mixing in the tanks. Actual blending can be accomplished in about 30 minutes, but longer times will not hurt the process and will provide an added measure of assurance. Tanks should be filled to an operating volume of no more than 450 gallons each. This allowance of approximately 10 percent expansion volume will accommodate the expansion of the liquid caused by the dispersed air. If foaming occurs, the fill level should be reduced accordingly. Samples for waste disposition shall be obtained after mixing has been completed (if appropriate) and the tank is being emptied for transport to a TSDF off site. Table 4 summarizes when these samples can be collected.

Air used to agitate the tanks should be free of oil. Oil contamination can be significant when substantial air rates are supplied for typical mixing times. Foaming of tank contents may be caused by salt content or the presence of oil.

Table 2. Calculation Results for 500-Gallon Tanks

500-Gallon Tanks		
Diameter	48	inches
Straight Side	65	inches
Head Depth (std Dish)	6.57	inches
Straight Side Volume	509	gal
Head Volume	32	gal
Total Volume	541	gal
Design Volume	500	gal
Design Liquid Level	66.3	inches
Design Straight Side Level	59.76	inches
Air Expansion	10%	
Expanded Volume	550	gal
Expanded Liquid Level	72.71	inches
Expanded Straight Side Level	66.15	inches
Working Straight Side Level	60	inches
Working Straight Side Volume	470	gal
Head Volume	32	gal
Working Volume	502	gal
Unexpanded Working Volume	456	gal
Gas Rates		
Minimum Gas Superficial Velocity	0.01	ft/s
Minimum Gas Rate	7.5	cfm
Maximum Gas Superficial Velocity	0.1	ft/s
Maximum Gas Rate	75	cfm

4.4 Twenty-Four Thousand Gallon Tank Blending

To guide the evaluation of the blending requirements in the 24,000-gallon tank, an approximately to-scale sketch like the one shown in Figure 2 was used. Volume and liquid calculation results are shown in Table 3.

An easily mixed horizontal tank would have a length approximately equal to its diameter, with a liquid level about three-quarters full. The 24,000-gallon tank has a length to diameter ratio of about 4:1. One option for improving tank mixing would be the simultaneous addition to and recirculation of the tank contents. This procedure was not considered practical with the existing piping and operating characteristics. When the tank is less than one-quarter full, the addition of new waste probably causes as much mixing as the pumped recirculation.

The situation for the tank one-quarter full is shown in Figure 2. The loops in the liquid approximate the internal recirculation patterns. Pumped recirculation entering the top and exiting the bottom will create a vertical velocity in the liquid. This forced motion will cause entrained motion to circulate in the remaining liquid. Usually, induced flow will only go so far before it begins internal recirculation. At that point, an internal circulation loop occurs that will induce a secondary loop of flow and so on. Figure 2 is only an approximation to the anticipated flow. The cross-section is broader at the liquid level than at the bottom, because of the curvature of the cylindrical tank. As the liquid level increases to half-full in Figure 2 and three-quarters full, the internal recirculation loops will increase in size and may be fewer in number.

For blending to occur in this tank, motion must be present throughout the liquid and each recirculation loop must mix with the adjacent loop. The longer the recirculation pump operates, the more likely motion will occur throughout the tank. Stopping and starting the pump in long cycles of an hour or so may enhance mixing between internal circulation loops, but will not reduce and may extend the total mixing time. The results of the calculations for volume and flow for the 24,000-gallon tank are shown in Table 3. Six to ten turnovers are typically required for complete blending in cylindrical tank geometries. Ten turnovers will require pump operation for about 20 hours at 100 gpm with the tank half full.

The 24,000-gallon tank will be difficult to blend well under any circumstances because of the long length to diameter ratio. A recirculation pump is not an efficient mixer, a situation complicated by the present location of the recirculation loop near one end of the tank. Ironically, the fuller the tank, the better the mixing pattern may be. With the tank half full (12,000 gallons), a recommended recirculation time of 20 hours (10 turnovers) should blend modest concentration differences. Samples for waste disposition shall be obtained after mixing has been completed (if appropriate) and the tank is being emptied for transport to a TSDF off site.

Table 3. Calculation Results for 24,000-Gallon Tank

24,000-Gallon Tank		
Diameter	126	inches
Total Length	466	inches
Straight Side Calculated	431.46	inches
Head Depth (Std Dish)	17.27	inches
Straight Side Volume	23,290	gal
Head Volume	576	gal
Total Volume	23,865	gal
Recirculation		
Recirculation Rate	100	gpm
Blending Turnovers	10	times
Half Full	12,000	gal
Recirculation Time	20	hrs

4.5 Blending in High Integrity Containers

High integrity containers (HICs) are portable, temporary tanks used for short-term storage of wastes generated from some time-limited operation. They are generally double-walled and do not require secondary containment. They can be a variety of sizes and shapes.

Air agitation of the HICs should be successful using an air rate in cubic feet per minute equal to 1.5 times the cross-sectional area of the tank in square feet. The actual time required for mixing will depend on the tank volume, but for typical portable containers, mixing time from one-half to one hour should be adequate. Samples for waste disposition shall be obtained after mixing has been completed (if appropriate) and the tank is being emptied for transport to a TSDF off site.

4.6 Sample Number

Sampling for waste characterization in blended tanks should be based on at least three samples. The samples may be analyzed separately for a measure of uniformity or combined and analyzed for a mean concentration of tank contents. The initial sample should be collected from the first discharge of the tank after the drains have been flushed. A second, intermediate sample should be taken when the tank is about half-empty. The third sample should be taken when the tank is nearly empty. These three samples are not intended to be a statistical average, but rather a sample of extremes at the top and bottom of the tank compared with the intermediate value. According to historical records, the waste is expected to have only minor variations in concentration and are anticipated to be easily blended.

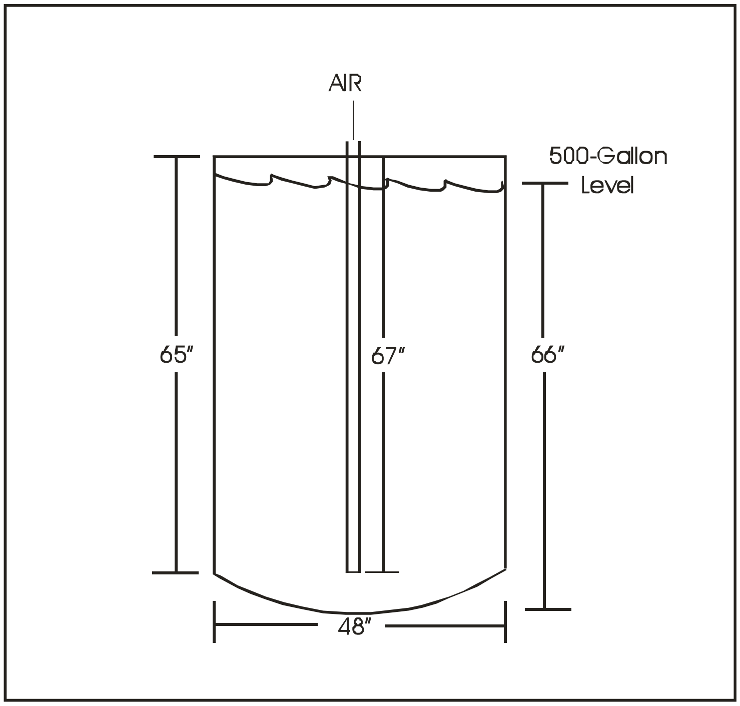


Figure 1. 500-Gallon Tanks

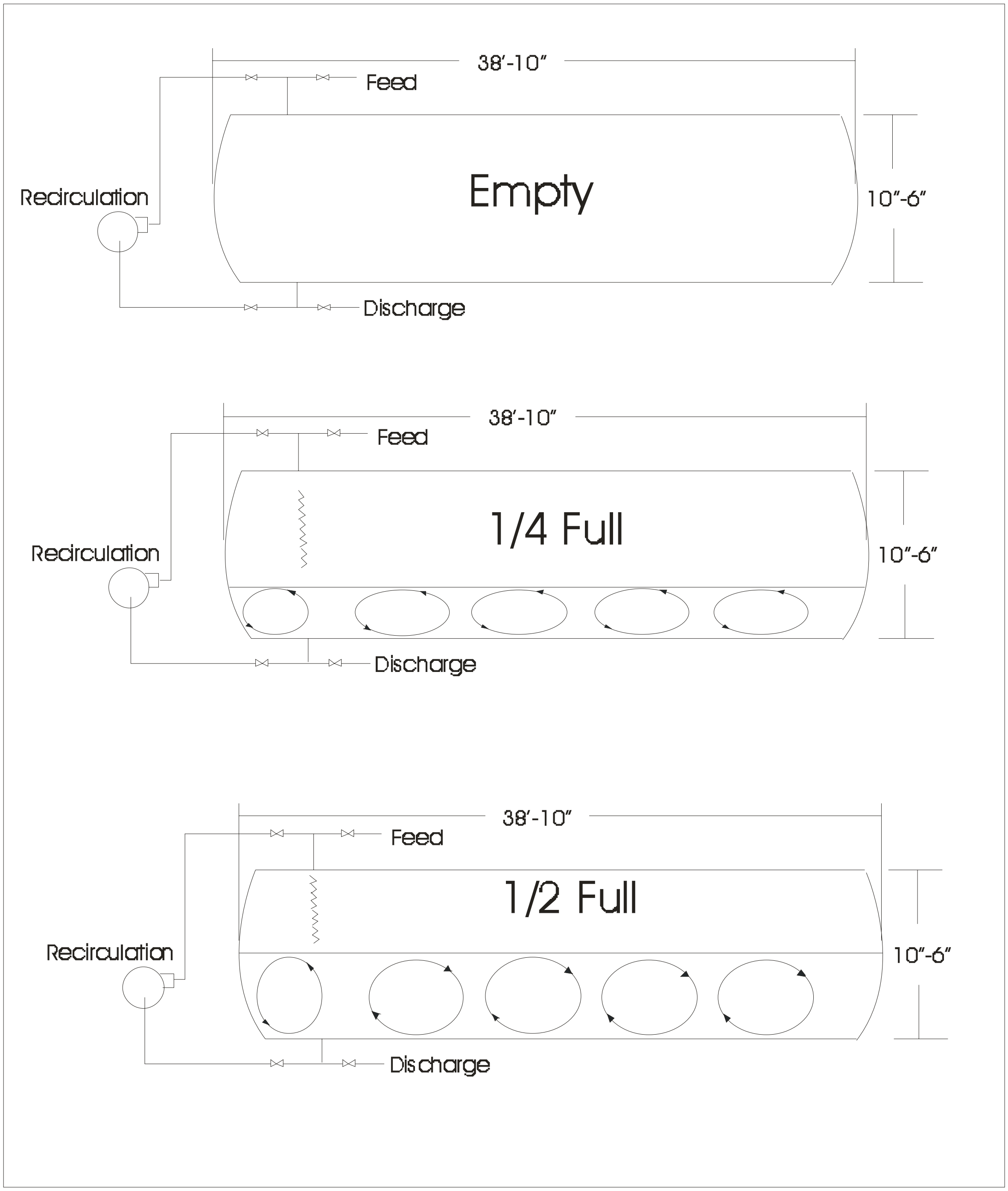


Figure 2. 24,000-Gallon Tanks

Table 4. Summary of Tank Mixing and Sampling Protocols

Tank Size/Type	Mixing Rate	Mixing Duration	Tank Turnovers	Sampling Effluent
500 gallons	Air flow rate of 10 to 25 cfm	Minimum 30 minutes	10	**3 samples**: 1st after one minute of emptying, 2nd at emptying mid-point, 3rd at conclusion of emptying
24,000 gallons	Recirculating pump at 100 gpm when tank >¼ full 50 to 60 gpm fill rate when tank is ≤¼ full	20 hours when tank is >¼ full While filling when tank is ≤¼ full	10 when tank is >¼ full While filling when tank is ≤¼ full	**3 samples**: 1st after one minute of emptying, 2nd at emptying mid-point, 3rd at conclusion of emptying
High Integrity Containers (HICs)	Air flow rate of 1.5 times the cross-sectional area (in square feet) in cubic feet per minute	30 minutes to one hour	Varies	**3 samples**: 1st after one minute of emptying, 2nd at emptying mid-point, 3rd at conclusion of emptying

5.0 DRUM SAMPLING GUIDELINES

Liquid waste is occasionally stored in 55-gallon drums that require characterization. There is considerable literature on the proper procedures to follow for sampling drums, based on prior knowledge of the contents. This guidance document will provide a general outline for proper and safe drum sampling.

5.1 Pre-Sampling Preparations

Samples should be collected in accordance with appropriate work plans or procedures. Where no formal written plan exists to direct the drum sampling, *ASTM D6063 - Sampling of Drums and Similar Containers by Field Personnel* should be consulted. This standard takes the sampler through a series of decisions that will help identify the proper equipment and procedures for sampling liquid waste in containers. Sampling procedures must remain flexible enough to be tailored to the situation as it is encountered. A trained and experienced sampler must collect or supervise the collection of samples from drums.

All paperwork about the drummed waste must be reviewed prior to collecting samples. The appropriate sampling equipment should be used. A dipper may be used with liquids that are not stratified. A Coliwasa or similar device should be used to collect representative samples of stratified materials. The sampling device must be compatible with the materials in the drum. Care should be taken to obtain a portion of each distinct layer in the drum in the same proportion as in the drum overall. Manufacturers' instructions specific to the sampling device should be followed. When in doubt as to whether the waste is stratified or not, it should be sampled as if it were stratified.

If stratified waste is anticipated and the drum has recently been moved, allow the drum to stabilize prior to sampling. Mixing is not necessary if the sampling device will obtain a sample of each layer present in the drum. Assign a unique number to the drum to be sampled. Slowly remove bung or lid, allowing any pressure or vacuum to equalize. Severely bulging or collapsed drums should not be opened by hand and may require remote equipment. A heavy cloth should be placed over the drum if it is possible that contents may spray during opening. If there is any evidence of a chemical reaction, the sampler should leave the area immediately and notify the WM Manager. All flammables or explosive materials should be sampled with non-sparking, grounded and insulated tools. Care should be taken that sampling equipment did not generate a static charge through packaging or shipping. If the lid or bung of the drum cannot be loosened, remote drum puncturing equipment should be used.

Once the drum is open, measure the level of the contents to ensure that the volume is consistent with the volume stated on the paperwork. Before lowering the measuring device into the drum, touch it to the side of the drum opposite to the opening to equalize any static charge that the drum may exhibit (bonding). Some sampling devices can be used as a measuring device by measuring the length of the liquid column once it is withdrawn.

Sample collection procedures should be followed once the sample has been obtained, including chain-of-custody, decontamination, sample preservation, jar labeling, field logs, and appropriate documentation. At a minimum, gloves should be worn when collecting a sample. In hazardous situations, hard hats, protective face shields, respirators, or other personnel protective equipment may be necessary. In this event, sampling should only proceed when a formal, approved Health and Safety plan is in place.

All drums should be closed and staged appropriately while awaiting analytical results. One sample per drum is recommended where different waste streams are involved. If multiple drums are generated from the same waste stream, a statistical approach or the Sampling Design Toolbox© can be used to design the number of drums that need to be sampled to represent the waste stream.

The following table suggests appropriate sampling device for various waste materials.

Table 5. Drum Sampling Equipment and Applicability

Equipment	ASTM Standard	One Liquid Layer or Mixed Multiple Layers	Unmixed Multiple Liquid Layers	Unmixed Liquid and Solid or Sludge Layers
Drum Thief		Suitable - Recommended	Suitable	Suitable
Dipper		Suitable	Unsuitable	Unsuitable
Coliwasa	D 5495	Suitable	Suitable	May be used, but not recommended
Syringe-Type		May be used, but not recommended	May be used, but not recommended	Suitable
Sludge Coring-Type		Unsuitable	Unsuitable	Suitable
Piston-Type		Suitable	Suitable	May be used, but not recommended

6.0 DOCUMENTATION AND APPROVAL

A Radioactive Waste Control Form (RWCF) and supporting documentation shall be prepared to document the mixing, sampling, analysis, and waste designation for each waste stream to be transported offsite for treatment or disposal. The generator, prior to sampling for waste determination, should prepare a sampling analysis plan and submit to WM for review and approval. The sample analysis plan will be used to document the design of the sampling program and the analysis of the sampling data for bulk containerized liquids.

The sampling analysis plan and supporting documentation is submitted to the WM along with the RWCF. WM will review the RWCF and supporting documentation to ensure that the waste was adequately characterized and Waste Acceptance Criterias (WACs) are met. During the review, the assigned WM reviewer shall contact the Waste Management Representative (WMR), Environmental Compliance Representative (ECR), Facility Support (FS) Representative, or generator if additional information is required. The generator, along with the Waste Management Representative, is responsible for preparing any additional documentation required by the disposal facility, EPA, DOT, or other responsible regulatory bodies.

7.0 ROLES AND RESPONSIBILITIES

Project Manager – The Project Manager is responsible for ensuring that this guidance, or an equivalent process, is followed for the proper determination of the waste. The Project Manager will ensure that all sampling technicians are properly qualified and that site safety procedures are followed during the sampling and handling of the waste. The Project Manager or designee shall review the applicable waste control form. He or she will ensure that all current and relevant data regarding the waste is taken into account in the design of the sampling and performed for waste container contents characterization.

Waste Management Representative/Generator (WMR) – The WMR/Generator will prepare the applicable waste control form. As needed, the WMR also will ensure that the sampling and sample results conform to the requirements of the TSDF to which the waste is designated to go and that all paperwork and required documentation has been prepared in accordance with BNL and WM internal requirements. The generator will sign and date the sheet when review is complete.

ES&H Coordinator (ESH) –The ESH Coordinator may be asked to evaluate the chemical and safety hazards of any new or unfamiliar chemicals and make recommendations for their safe management and sampling.

Waste Management (WM) Manager – The WM Manager or designee shall be responsible for reviewing the applicable waste control form. The WM Manager or designee is responsible for reviewing the sampling and mixing procedures.

8.0 REFERENCES

1) American Society of Testing Materials, *Annual Book of ASTM Standards*, Section 11, vol. 11.04: Environmental Assessment; Hazardous Substances and Oil Spill Responses; Waste Management; Environmental Risk Management," 1999.

   a) D 5495 - 94 – Standard Practice for Sampling With a Composite Liquid Waste Sampler (COLIWASA), March 1994.

b) D 5743-97 – Standard Practice for Sampling Single or Multilayered Liquids, With or Without Solids, in Drums or Similar Containers, March 1998.

c) D 6063-96 – Standard Guide for Sampling of Drums and Similar Containers by Field Personnel, February 1997.

d) D 5956-96 – Standard Guide for Sampling Strategies for Heterogeneous Wastes, December 1996.

e) D 6044-96 – Standard Guide for Representative Sampling for Management of Waste and Contaminated Media, January 1997.

f) D 6051-96 – Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities, February 1997.

2) Battelle Memorial Institute, “Waste Management Operating Procedure: Identification, Segregation, Separation, and Documentation of Low Level and Radioactive Mixed Waste,” WA-OP-020, Revision 6, January 1999.

3) Battelle Memorial Institute, “Waste Management Operating Procedure Sampling of Waste Materials for Chemical and/or Radiological Characterization,” WA-OP-033, Revision 3, June 1998.

4) Peterson, Chris A., and Richard A. Sexton, “An Approach for Sampling Solid Heterogeneous Waste at the Hanford Site Waste Receiving Processing and Solid Waste Projects,” US Department of Energy Low-Level Radioactive Waste Management Conference, 1993, http://www.inel.gov/resources/research/.llrw/1993 Conference/Technical_Track/paper08.html

Low-Level and Transuranic Waste Generator Characterization Guidance

Contents

1.0 Low-Level and Transuranic Waste Defined

Waste contaminated with low-level radioactive components only, or with radioactive components and non-RCRA regulated constituents is LLW. BNL may manage LLW or TRU waste with only non-RCRA regulated constituents as Mixed Waste, for the purpose of waste segregation, but such wastes are technically LLW or TRU wastes. Waste with transuranic (TRU) nuclides with atomic number greater than 92 with half-life greater than twenty (20) years, and in concentrations that are less than 100 alpha nanocuries per gram (nCi/g) are also considered LLW. Waste with transuranic (TRU) nuclides with atomic number greater than 92 with half-life greater than twenty (20) years, and in concentrations that are equal to or greater than 100 alpha nanocuries per gram (nCi/g) are considered TRU waste.

All LLW and TRU waste must be characterized and accepted for transfer to a Waste Management (WM) facility and/or approved by WM for shipment to an off-site treatment, storage, or disposal facility (TSDF). Your characterization will allow WM to safely handle, segregate, store, treat, and ship your waste off-site for disposition. Waste that is not properly characterized may be subject to rejection by WM.

To determine if your waste needs to be sampled and analyzed for radionuclides and for absence of RCRA hazardous constituents, contact your Waste Management Representative (WMR), Environmental Compliance Representative (ECR), or the WM Radioactive Waste Program Manager for assistance.

A generator must know in advance that the process being used will create LLW or TRU waste, in accordance with BNL's Work Planning and Control Management System Description, and as required by the Work Planning and Control for Experiments and Operations Subject Area. Contact your Environmental Compliance Representative (ECR) for assistance with planning work activities that may generate radioactive wastes.

Radionuclide Quantification

Activity in the waste may alternatively be determined by mass balance or calculating activation yields. Mass balance may be used to calculate activity in a controlled process where all inputs and outputs of radioactive material are known. For example, a small research project conducted in a laboratory hood may have detailed records of radioisotope inventory entering the hood and detailed logs of radioisotopes leaving the hood as products of the experiment. A conservative estimate of the activity in the waste could be obtained by mass balance (corrected for decay if necessary). If these methods were used to calculate activity, the Radioactive Waste Control Form (RWCF) or the Accountable Nuclear Material Waste Control Form (ANMWCF) must be submitted with an attachment detailing the utilized method. Backup information such as typical receiving reports, log book pages, and other substantiating material should form a traceable, auditable record.

If the waste item itself is a product of neutron activation (e.g., a reactor component), activity of the waste can be calculated using PK (neutron flux, exposure time, elemental composition of item, etc.) combined with a recognized computer code for activation calculations. Copies of supporting documentation must be attached to the RWCF/ANMWCF.

If the waste stream consists of discarded items that have been assayed or counted (e.g., samples from analytical laboratory, smears), waste stream activity would be the sum of individual components. Alternatively, the entire waste stream may be assayed using an approved method for the type of radioisotopes present. If these methods are chosen, the generator should provide the technique for counting or assaying and method for obtaining total activity as an attachment to the RWCF/ANMWCF, provide information about method and total activity, and maintain auditable records to support submitted information.

Characterization is performed using process knowledge, sampling and analysis, or direct measurement of the waste. The choice of method to use usually depends on the characteristics of the radionuclides in the waste (i.e., depending on whether gamma, beta, or alpha emitters are present) and the waste material itself. It is not uncommon to use all three methods or a combination of the methods for characterizing waste.

2.0 Process Knowledge

LLW and TRU waste that is generated at BNL may be characterized by waste generators through their knowledge of the process that generated the waste. There are circumstances where the U.S. Environmental Protection Agency (EPA)/Ecology protocol sampling and analysis are not feasible or necessary for characterization of hazardous constituents (40 CFR 262.11, "Hazardous Waste Determination" [EPA 1987]). Under these circumstances, techniques that rely primarily on documented knowledge of raw materials, processes and material balances can be employed to characterize wastes. Such techniques may be employed when one or more of the following conditions are met.

- The waste stream is difficult to sample because of physical form. This primarily applies to pieces of metal (e.g., shielding) that contain hazardous constituents in their composition rather than as a residue that could be removed for testing or in a decontamination process.
- Sampling and analysis of the waste stream could result in unacceptable risks of radiation exposure [i. e., not consistent with the as low as reasonably achievable (ALARA) precept of the DOE].
- Waste is too variable to be characterized by one set of samples (e.g., drums containing contaminated protective clothing, rags, and absorbent).
- Process knowledge is available and sufficiently documented to provide a complete characterization of the waste stream (e.g., MSDS, mass balances, etc.).

Process knowledge will not be accepted by WM unless it can be shown that the process producing the waste is rigidly controlled, such as through procedures governing waste segregation of input materials procurement. Through an understanding of the material input to a process and manner which the material is manipulated or handled, the waste may be characterized by use of a model which accounts for the quantities which will be included in the waste from that process. Appropriate documentation must accompany the RWCF/ANMWCF to show that the use of process knowledge is appropriate. Examples of appropriate documentation include:

- Interview information
- Logbooks
- Procurement records
- Qualified analytical data
- Radiation work packages
- Procedures and/or methods of accomplishment
- Process flow charts
- Inventory sheets
- Vendor information
- Mass balance from an uncontrolled process (e.g., spill cleanup)
- Mass balance from a process with variable inputs and outputs (e.g. washing/cleaning methods).
- Material Safety Data Sheets (MSDS)

If the information is sufficient to quantify constituents of regulatory concern and determine waste characteristics, as required by the regulations and TSDF waste acceptance criteria (WAC), the information is considered acceptable knowledge.

This information is documented on a Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF), including supporting documentation, in accordance with the requirements of the Radioactive Waste Management Subject Area.

If you are performing a new process that will generate LLW or TRU waste, contact your area WMR, who can help you determine the appropriate documentation to complete.

3.0 Sampling and Analysis

Sampling and analysis may be required if:

- Process knowledge is not available or adequate to completely characterize the waste, and/or
- You are uncertain as to whether regulated hazardous materials may be present.

This method of characterizing radioactive waste involves taking a sample or samples of the waste and analyzing the sample. Sampling of radioactive waste can involve risk of exposure to the sampler and support personnel, thus the risk-to-benefit of the sampling activity must be considered. If sampling is performed, proper health and safety precautions must be taken. The samples are often times taken based on a statistical approach. Analyses for the analytes (i.e., radionuclides) is usually performed in a laboratory.

Sampling and analysis is most effective when approved sampling plans, which specify sampling frequency, locations, and methodology, are used by trained sampling personnel. This ensures that sampling errors are minimized. In addition, certified analytical laboratories should be used to ensure accurate analyses. Validation and verification of the analytical results is often performed as an additional measure of quality assurance.

The Analytical Services Laboratory (ASL) or an approved offsite laboratory will do the analyses in accordance with the generator defined sampling plan. Your WMR will provide assistance to determine the type of analysis required to characterize your waste and provide guidance on characterization procedures for uncharacterized wastes.

You should provide the sampling personnel as much information about the composition of your waste as possible. Before collecting the sample, the sampling technician or WMR reviews the sampling method and strategy to determine if they are safe and appropriate for the waste.

If RCRA hazardous constituents above regulatory limits are contained in your LLW or TRU waste, then the waste must be characterized as mixed waste (see the Mixed Waste Generator Characterization Guidance exhibit in the Mixed Waste Management Subject Area).

There are several sampling methods for the various kinds of waste. The sampling method and devices used to sample a container of waste depend on the generator-supplied information. Requests for sampling are in accordance with Environmental and Waste Management Services

(EWMS) procedure EM-SOP-105, Request for Sampling and Supplemental Health and Safety Plan, or an equivalent approved facility- or activity-specific procedure.

If you are generating LLW or TRU waste and are unable to calculate the activity or determine the radionuclide level in the waste through process knowledge or waste assay, then you need to arrange for it to be sampled. Contact your WMR for assistance.

Chain of Custody and Analytical Instructions (COC)

If your waste requires analysis, you are responsible for requesting that it be sampled and analyzed. Your WMR or ECR will assist you in filling out a COC, taking samples, and arranging for the appropriate analysis.

Waste samples used for the analytical characterization of the waste streams will be submitted to the onsite Analytical Services Laboratory (ASL) for screening for radioactivity and onsite analysis, or will be shipped to an approved contract laboratory for analysis. EM-SOP-109, Chain of Custody Procedure defines requirements for documenting the possession (custody) of samples from the point of collection to receipt of the sample by the analytical laboratory. This procedure also allows for providing waste analysis instructions. The RWCF/ANMWCF number and/or the container serial number for each waste package sampled will be recorded so that the sample is traceable to a specific waste parcel or container.

Sampling Methods

Provide the sampling personnel as much information about the composition of your waste as possible. This exchange is important because, before collecting the sample, the sampling technicians or WMR will select a sampling method and strategy that is safe and appropriate for the waste.

There are several sampling methods for the various kinds of waste. The sampling method and device used to sample a waste depend on the generator-supplied information based on knowledge of the waste. Sampling must meet EPA SW-846 industry standards, or equivalent standards. EPA publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, is a compilation of analytical and sampling methods that have been evaluated and approved for use in complying with the RCRA regulations. SW-846 functions primarily as a guidance document setting forth acceptable sampling methods. Information about other methods and analytical technologies may be accessed through the EPA's Technology Innovation Office Clu-In web page.

The ability to characterize waste adequately is based on obtaining enough samples to ensure that a representative population of samples is collected. The EPA has guidance documents and methods are based on media being sampled. If a small amount of waste must be sampled such as a drum one sample may be all that is necessary as long as the waste is known to be homogeneous. Larger waste streams, such as soil piles, will require numerous samples. The Environmental and Waste Management Services (EWMS) Division maintains the Environmental Monitoring SOPs web site providing sampling guidance for environmental media which should be followed if applicable to your waste.

To ensure that each waste stream is characterized properly and that the analytical data is truly representative in nature the following table should be used for characterizing the different waste streams. Sampling guidance for characterization for bulk waste streams (e.g., generated as a result of environmental restoration activities) is provided in Appendix B, Bulk Non-Liquid Waste Characterization Sampling Guidance of the BNL Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description. This guidance document also includes a Waste Determination Toolbox to aid in the statistical analysis of the number of samples to be used to make a waste determination. This tool is provided in Appendix B, Waste Determination Toolbox of the BNL Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description. The number of samples per waste stream is based on statistical methods and an acceptable deviation between the samples. Preliminary data used for clean up level purposes may be used for screening, however unless all of the constituents required by the disposal site waste acceptance criteria (WAC) have been accounted for, further characterization samples will be mandatory.

4.0 Direct Radiation Measurement

Direct measurements refer to measuring waste in a packaged or unpackaged form. These methods are generally based on the measurement of photons or gamma-rays emitted by the radionuclides present in the waste. Radiochemical techniques may be used to process the samples, isolate the radionuclides, and/or to achieve "weightless" matrices. Liquid scintillation is commonly used for beta emitters such as H-3 and C-14 while alpha spectroscopy is used for uranium and actinides. Gross alpha/beta counting is a semi-quantitative technique for measuring overall radioactivity without a great deal of sample preparation. This technique has the advantage of being sensitive to a wide range of nuclides, but does not inherently provide any reliable information about the identity of the radioactive isotopes present. Alpha spectroscopy can determine the identity of the alpha emitters present, but because nuclides from different elemental series have overlapping energies, a chemical elemental separation of the sample must first be performed.

Gamma spectroscopy is used to identify and quantify the gamma-ray emitting radionuclides. Proper calibration of the measurement equipment is absolutely necessary in order to achieve accurate results. In addition, corrections have to be made several factors such as the density and homogeneity of the waste matrix, the source-to-detector and waste package geometry, half-lives of the radionuclides, shielding (e.g., waste container walls), and radiation background. Process knowledge or historical information for legacy waste) can be used to aid the measurements to ensure that the characterization is as comprehensive as possible.

Quantification and identification of the radionuclides present in radioactive waste through direct measurements is sometimes referred to a nondestructive assay (NDA). NDA tools and equipment include waste drum and box scanners/counters, curie monitors, and neutron devices incorporating active, passive, or active and passive neutron interrogation techniques. The neutron devices are most often used to quantify transuranic material.

To simplify characterization in the field, scaling factors can be used. Scaling factors are ratios used to quantify a set of previously identified radionuclides based on a single radiation measurement. In most cases, the single measurement is a radiation exposure rate reading taken with a portable radiation protection instrument such as an ion chamber or a geiger-mueller (GM) detector. Scaling is most effective when the characteristics of the waste and makeup of the radionuclides is well known and consistent. Waste from certain processes can be analyzed and characterized up front to develop scaling factors that can then be applied to exposure rate readings to obtain the activities of the radionuclides present in the waste.

5.0 Radionuclide Reporting

As a low-level waste generator, you are responsible for identifying all radionuclides present in your waste stream. Be sure to list all radionuclides on the RWCF or ANMWCF for your LLW or TRU waste, as specified in the Radioactive Waste Management Subject Area.

Exempt Radionuclides

Specific radionuclides may be exempt from reporting in accordance with the requirements of the applicable TSDF WAC. Examples include:

- Short-lived daughter products considered to be in equilibrium with their long-lived parent. For example, Th-234, and Pa-234 are assumed to be in equilibrium with U-238 since the half-live of these daughter (24 days and 1.2 minutes, respectively) are much shorter compared to U-238 (4.5E09 years). [Envirocare]

- Radionuclide in concentration less than 1.0E06 Ci per cubic meter, and not otherwise reportable. [Hanford].

Contact your WMR with specific questions.

6.0 Documentation

Characterization Documentation

Before LLW or TRU waste can be transferred from the generator's facility to WM, a documentation package must be completed.

A documentation package contains information about the waste that enables WM to properly manage and track the waste and is required before transport to a WM facility.

The documentation package consists of:

- Radioactive Waste Control Form or Accountable Nuclear Material Waste Control Form
- Radioactive Waste Inventory Form
- Sampling and analysis plan (if applicable)
- Analytical data (if applicable)

- Draft Waste Profiles (if applicable)

Instructions for preparing the required waste characterization documentation are provided in the Radioactive Waste Management Subject Area .

Contact your area WMR, who can provide assistance in preparation of the appropriate documentation.

PROHIBITED ARTICLES IN RADIOACTIVE SOLID WASTE PACKAGES, (LLW, compactible, and noncompactible)

- **Incandescent and Fluorescent Light Bulbs**, flashlight, drop lights, and floodlights
- **Batteries**, flashlight/beeper dry cells and emergency light batteries
- **Lead**, bricks, sheets, fuses, printed circuit boards, computer monitors, televisions, bronze strainers/floor drains/fittings, brass sand-cast elbow/valves, items that would fail TCLP** (i.e., compounds not otherwise specified [NOS])
- **Liquids**, any amount of unabsorbed, nonregulated free liquids (unless asbestos waste 1% free - OK) - sorbent must be added to all final packaging with condensation potential.
- **Aerosol Cans**, **see pollution prevention initiative (e.g., pressurized containers that include aerosol cans, fire extinguishers, and lecture bottles)
- **Mercury**, thermostats, relays, thermometers, and compounds NOS
- **Unauthorized Chemicals/Solvents**, **contact your WMR
- **Combo Respirator Cartridges**, where combos are, mixed wastes exists, there are some combos regulated just by the reagents within them (e.g., ammonia) **
- **Syringes, scalpels, hypodermic needles**, even if nonmedical application**
- **Dismantled circuit boards**, may contain hazardous materials**
- **Drager/Sensodyne tubes**, may contain hazardous materials**
- **Animal waste/animal carcasses**
- **Green or wet vegetation**
- **Oils, fuels, and other organic liquids**, even if absorbed into solid

Note: Each bulleted item is a separate and distinct waste and should be packaged/labeled accordingly.**

Questions/path forward for prohibited articles/items considered mixed or State regulated - **ask your Waste Management Representative, or contact the Radioactive Waste Program Manager **or** Mixed Waste Program Manager**.**

RADIOACTIVE WASTE ACCUMULATION AREA BASIC RULES

1. All waste has been placed in the proper packaging or container, and packages or containers are in good condition, labeled, and surveyed.

2. Radioactive waste bags are J-sealed and RWCFs or ANMWCFs and supporting characterization documentation have been completed for each waste item.

3. Liquid Low-Level Radioactive Wastes (LLLRW) is placed in secondary containment.

4. Wastes are segregated by classification (i.e., Decay-in-storage, accountable waste, liquid waste, mixed waste, LLRW, etc.)

5. Appropriate spill-control equipment is located in or adjacent to the accumulation area.

6. No waste has been staged for $\geq$90 days.

7. Aisles are clear of obstructions and can be easily accessed.

8. Area is periodically surveyed and current dose rates are posted in accordance with the BNL Radiological Control Manual.

9. At a minimum, the accumulation area is inspected monthly.

QUESTIONS?

Contact the Radioactive Waste Program Manager

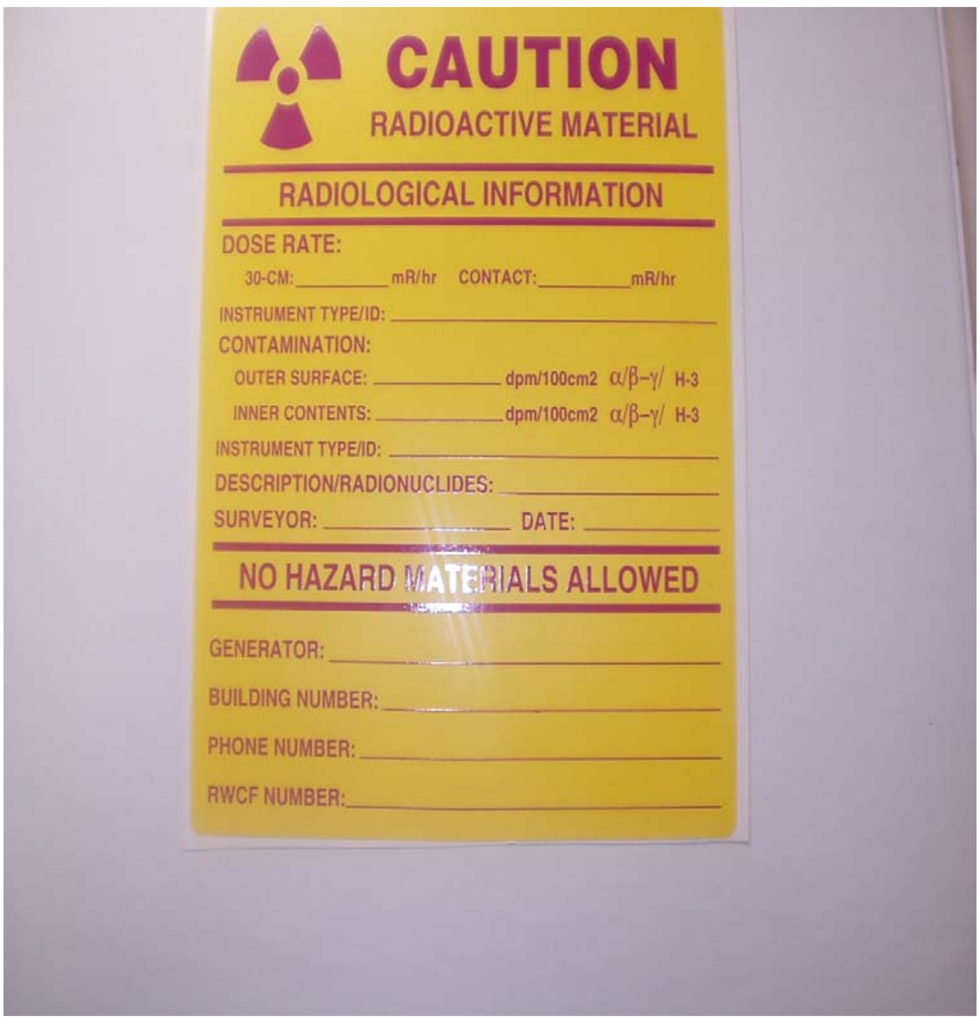
Call ext. 7251 or 7488

Subject Area: ***Radioactive Waste Management***

Radioactive Waste Label

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

This label is available from Central Stock.



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5.0-082003/standard/0h/0h03e011.htm
5.0-082003/standard/0h/0h03e011.jpg

Send a question or comment to the SBMS Help Desk
Disclaimer

Subject Area: ***Radioactive Waste Management***

Radionuclides Eligible for Decay in Storage

Effective Date: **December 2000**
Point of Contact: Radioactive Waste Program Manager

ISOTOPE	HALF-LIFE (days)	MINIMUM HOLD TIME PRIOR TO DISPOSAL (days)
Ag-111	7.45	75
As-74	17.9	179
As-76	1.10	11
As-77	1.61	17
Au-198	2.70	27
Au-199	3.15	32
Ba-131	12	120
Ba-140	12.8	128
Be-7	53	530
C-11	0.014	1
Ca-47	4.53	46
Cd-115	2.23	23
Cd-115M	43	430
Ce-141	33	330
Cr-51	27.8	278
Cu-64	0.53	6
Er-169	9.4	94
F-18	0.08	1
Fe-59	45	450
Ga-68	0.05	0.5
Ga-72	0.59	6

Tc-99m	0.25	3
Tl-201	3.04	31
Y-91	58.8	588
Zr-95	65	650

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3.0-122000/standard/0h/0h04e011.htm

Subject Area: ***Radioactive Waste Management***

Yellow LLRW Bag

Effective Date: **December 2000**

Point of Contact: Radioactive Waste Program Manager

This bag is available from Central Stock.

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The only official copy of this file is the one online in SBMS. Before using a printed copy, verify that it is the most current version by checking the document effective date on the BNL SBMS website.

3.0-122000/standard/0h/0h11e011.htm
1.0-061999/standard/0h/0h11e011.jpg

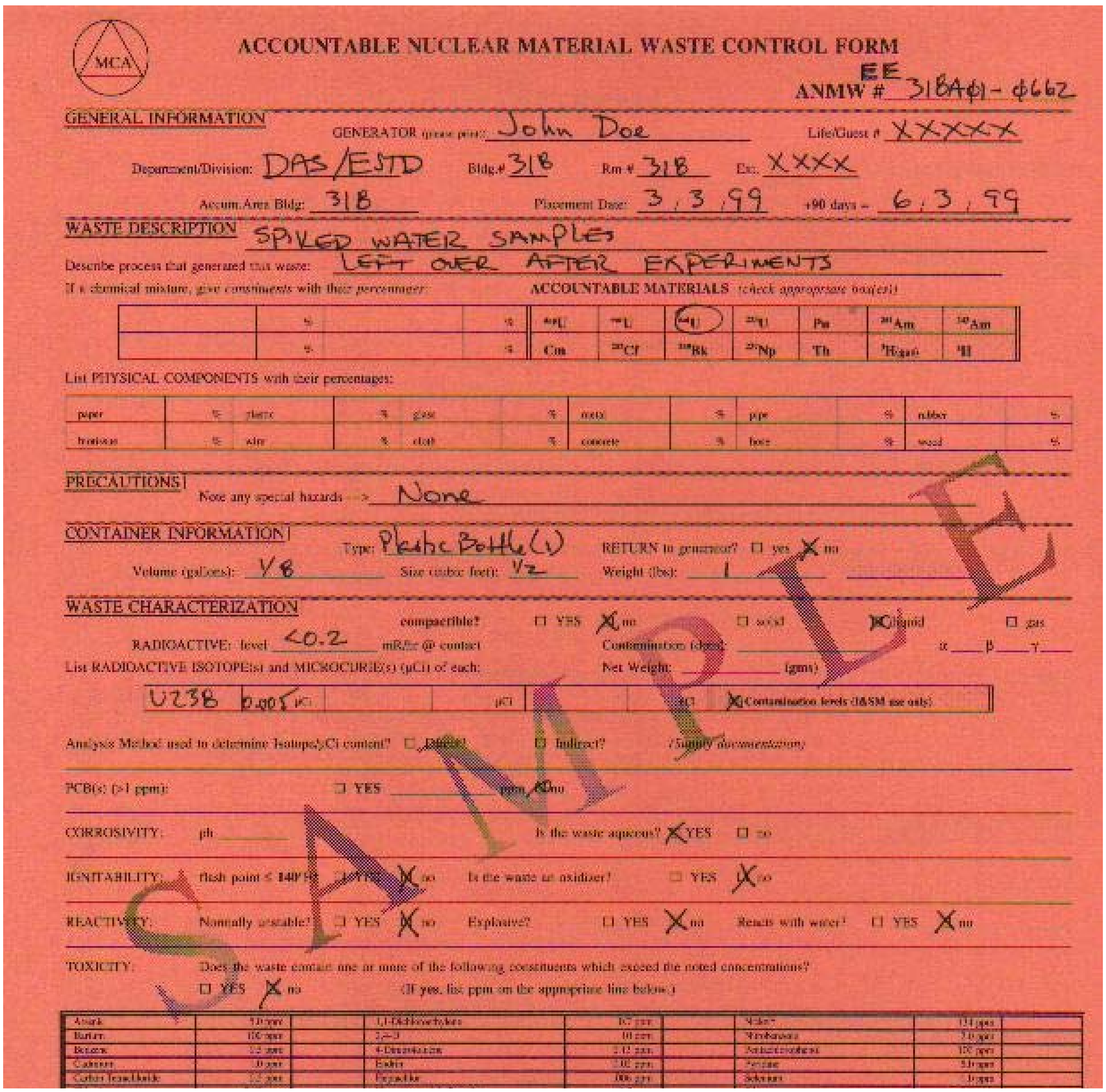
Subject Area: ***Radioactive Waste Management***

Accountable Nuclear Material Waste Control Form

Effective Date: **February 2002**

Point of Contact: Radioactive Waste Program Manager

This form is available from the Isotopes & Special Materials Group.



MCA

ACCOUNTABLE NUCLEAR MATERIAL WASTE CONTROL FORM

ANMW # EE 318A01-0662

GENERAL INFORMATION

GENERATOR (please print): John Doe Life/Guest # XXXXX

Department/Division: DAS/ESTD Bldg.# 318 Rm # 318 Ext. XXXX

Accum.Area Bldg: 318 Placement Date: 3, 3, 99 +90 days = 6, 3, 99

WASTE DESCRIPTION SPIKED WATER SAMPLES

Describe process that generated this waste: LEFT OVER AFTER EXPERIMENTS

If a chemical mixture, give constituents with their percentages:

ACCOUNTABLE MATERIALS (check appropriate box(es))

	%		%	U	U	(U) circled	U	Pu	Am	Am
	%		%	Cm	Cf	Bk	Np	Th	H	H

List PHYSICAL COMPONENTS with their percentages:

paper	%	plastic	%	glass	%	metal	%	pipe	%	rubber	%
[illegible]	%	wire	%	cloth	%	concrete	%	hose	%	wood	%

PRECAUTIONS

Note any special hazards --> None

CONTAINER INFORMATION

Type: Plastic Bottle(1) RETURN to generator? ☐ yes ☒ no

Volume (gallons): 1/8 Size (cubic feet): 1/2 Weight (lbs): 1

WASTE CHARACTERIZATION

compactible? ☐ YES ☒ no ☐ solid ☒ liquid ☐ gas

RADIOACTIVE: level <0.2 mR/hr @ contact Contamination (dpm): α ___ β ___ γ ___

List RADIOACTIVE ISOTOPE(s) and MICROCURIE(s) (μCi) of each: Net Weight: ______ (gms)

U238 0.005 μCi | μCi | μCi | ☒ Contamination levels (I&SM use only)

Analysis Method used to determine Isotope/Ci content? ☐ Direct? ☐ Indirect? (Supply documentation)

PCB(s): (>1 ppm): ☐ YES ______ ppm ☒ no

CORROSIVITY: ph ______ Is the waste aqueous? ☒ YES ☐ no

IGNITABILITY: flash point ≤ 140°F? ☐ YES ☒ no Is the waste an oxidizer? ☐ YES ☒ no

REACTIVITY: Normally unstable? ☐ YES ☒ no Explosive? ☐ YES ☒ no Reacts with water? ☐ YES ☒ no

TOXICITY: Does the waste contain one or more of the following constituents which exceed the noted concentrations?
☐ YES ☒ no (If yes, list ppm on the appropriate line below.)

Arsenic	5.0 ppm		1,1-Dichloroethylene	0.7 ppm		Nickel	134 ppm	
Barium	100 ppm		2,4-D	10 ppm		Nitrobenzene	2.0 ppm	
Benzene	0.5 ppm		2,4-Dinitrotoluene	0.13 ppm		Pentachlorophenol	100 ppm	
Cadmium	1.0 ppm		Endrin	0.02 ppm		Pyridine	5.0 ppm	
Carbon Tetrachloride	0.5 ppm		Heptachlor	0.008 ppm		Selenium	1.0 ppm	

SAMPLE

Chlordane	0.03 ppm		Hexachloro-1,3-butadiene	0.5 ppm		Silver	5.0 ppm
Chlorobenzene	100 ppm		Hexachlorobenzene	0.13 ppm		Tetrachloroethylene	0.7 ppm
Chloroform	6.0 ppm		Hexachloroethane	3.0 ppm		Thallium*	130 ppm
Chromium	5.0 ppm		HOC*	1000 ppm		Toxaphene	0.5 ppm
m-Cresol	200 ppm		Lead	5.0 ppm		Trichloroethylene	0.5 ppm
o-Cresol	200 ppm		Lindane	0.4 ppm		Vinyl Chloride	0.2 ppm
p-Cresol	200 ppm		Methoxychlor	10 ppm		2,4,5-TP (Silvex)	1.0 ppm
1,4-Dichlorobenzene	7.5 ppm		Methyl Ethyl Ketone	200 ppm		2,4,5-Trichlorophenol	400 ppm
1,2-Dichloroethane	0.5 ppm		Mercury	0.2 ppm		2,4,6-Trichlorophenol	2.0 ppm

GENERAL: Is the waste an unused chemical? ☐ YES ☒ no Waste from a spill cleanup? ☐ YES ☒ no

Was the waste used as a solvent? ☐ YES ☒ no For degreasing? ☐ YES ☒ no

CERTIFICATION *I certify that, to the best of my knowledge, the information provided above is true and complete, and that I have minimized the amount and toxicity of the waste to the extent practicable.*

John Doe 2/3/99
Generator's signature Date

Jane Doe 3/3/99
Reviewed by (S&EP Representative) Date

Bob White 3/3/99
Isotopes & Special Materials Approval Date

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Decay in Storage (DIS) Record

Department: ________________________________ Room number: ________________________

Name of waste generator: ____

Date of last addition of waste to container (placement date): ______________________________

Date the waste will be eligible for removal from DIS (min. 10 halflives): __________________

Radionuclides disposed: ____

Survey instrument used and calibration date: ____

Serial number: _______________________

Background dose rate: ________________________

Dose rate measured at the surface of the container or analytical result: ________________________

____

Date removed from the DIS program: ____________________

Generator signature: ____

Life number: ___________________________ Date: ____________________________________

NOTE: THE WASTE GENERATOR MUST RETAIN THIS FORM FOR NO LESS THAN THREE YEARS FROM THE DATE OF DISPOSAL

For Waste Management Division (WMD) personnel only

Original RWCF number: ____________________ New HWCF/RWCF number: _______________
(Circle one)

Surveyor's signature: ____
Life number: ________________ Date: ____________________

WMD signature: ____
Life number: ________________ Date: ____________________

RADIOACTIVE WASTE ACCUMULATION AREA MONTHLY INSPECTION CHECKLIST

Accumulation Area: ____

	Status: **Sat.**	**Unsat.**	**N/A**
1. Area is clearly identified and posted with a **"Radioactive Waste"** sign.	[]	[]	[]
2. All waste has been placed in the proper packaging or container, and packages or containers are in good condition, labeled, and surveyed.	[]	[]	[]
3. All Radioactive waste bags are J-sealed, packages and containers are sealed, and RWCFs or ANMWCFs and supporting characterization have been completed for each item.	[]	[]	[]
4. All waste has been segregated by classification (i.e., Decay in Storage, accountable waste, liquid waste, mixed waste, LLRW).	[]	[]	[]
5. Spill control equipment is located in or adjacent to the Radioactive Waste Accumulation Area.	[]	[]	[]
6. Area is bar coded by Waste Management, and bar code is in satisfactory condition.	[]	[]	[]
7. All sinks and floor drains in areas where Liquid Low-Level Radioactive Waste (LLLRW) is staged are plugged.	[]	[]	[]
8. Aisles are unobstructed, allowing access to all waste containers	[]	[]	[]
9. Area is periodically surveyed and current dose rates are posted	[]	[]	[]
10. Liquid wastes are in secondary containment and staged to prevent freezing.	[]	[]	[]
11. No waste has been staged for >90 days.	[]	[]	[]

Comments section. Document all corrective actions here (use reverse side if more room is needed):

____
____
____
____
____
____

____________________________________ ________________

Radioactive Waste Accumulation Area Manager or Designee Signature — Date

Radioactive Waste Accumulation Area Registration Form

Fill in the required information and send the form to Waste Management.

Department:

Building:

Location within building:

Area manager:

Phone extension:

Type(s) of waste to be stored in area*:

Location of entrance to area and accessibility restrictions:

***Note:** **Examples of types of waste include Liquids, Drums, Compactible and Non-Compactible, and Low Level Radioactive Waste (LLRW).**

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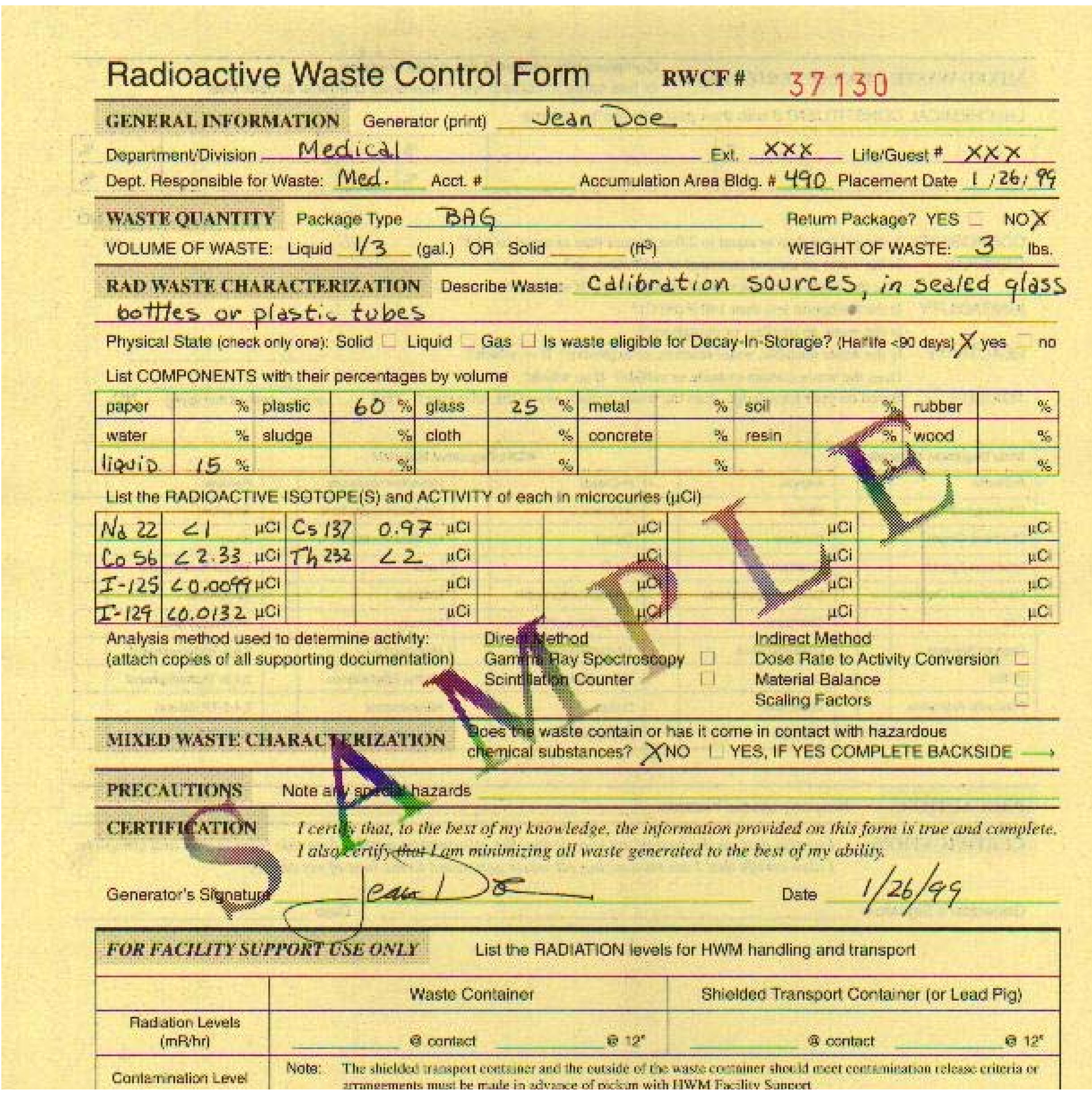
Subject Area: ***Radioactive Waste Management***

Radioactive Waste Control Form

Effective Date: **December 2000**

Point of Contact: Radioactive Waste Program Manager

This form is available from the Waste Management Administrative Assistant.



Radioactive Waste Control Form

RWCF # 37130

GENERAL INFORMATION Generator (print) Jean Doe

Department/Division Medical Ext. XXX Life/Guest # XXX

Dept. Responsible for Waste: Med. Acct. # ______ Accumulation Area Bldg. # 490 Placement Date 1 /26/ 99

WASTE QUANTITY Package Type BAG Return Package? YES ☐ NO ☒

VOLUME OF WASTE: Liquid 1/3 (gal.) OR Solid ______ (ft³) WEIGHT OF WASTE: 3 lbs.

RAD WASTE CHARACTERIZATION Describe Waste: Calibration sources, in sealed glass bottles or plastic tubes

Physical State (check only one): Solid ☐ Liquid ☐ Gas ☐ Is waste eligible for Decay-In-Storage? (Half-life <90 days) ☒ yes ☐ no

List COMPONENTS with their percentages by volume

paper %	plastic 60 %	glass 25 %	metal %	soil %	rubber %
water %	sludge %	cloth %	concrete %	resin %	wood %
liquid 15 %	%	%	%	%	%

List the RADIOACTIVE ISOTOPE(S) and ACTIVITY of each in microcuries (µCi)

Na 22	<1 µCi	Cs 137	0.97 µCi		µCi		µCi
Co 56	<2.33 µCi	Th 232	<2 µCi		µCi		µCi
I-125	<0.0099 µCi		µCi		µCi		µCi
I-129	<0.0132 µCi		µCi		µCi		µCi

Analysis method used to determine activity: (attach copies of all supporting documentation)

Direct Method: Gamma Ray Spectroscopy ☐ Scintillation Counter ☐

Indirect Method: Dose Rate to Activity Conversion ☐ Material Balance ☐ Scaling Factors ☐

MIXED WASTE CHARACTERIZATION Does the waste contain or has it come in contact with hazardous chemical substances? ☒ NO ☐ YES, IF YES COMPLETE BACKSIDE →

PRECAUTIONS Note any special hazards

CERTIFICATION *I certify that, to the best of my knowledge, the information provided on this form is true and complete. I also certify that I am minimizing all waste generated to the best of my ability.*

Generator's Signature Jean Doe Date 1/26/99

FOR FACILITY SUPPORT USE ONLY List the RADIATION levels for HWM handling and transport

	Waste Container		Shielded Transport Container (or Lead Pig)	
Radiation Levels (mR/hr)	______ @ contact	______ @ 12"	______ @ contact	______ @ 12"
Contamination Level	Note: The shielded transport container and the outside of the waste container should meet contamination release criteria or arrangements must be made in advance of pickup with HWM Facility Support.			

SAMPLE

Surveyor's Sig. ______ Life # ______ Date ______

FOR HAZARDOUS WASTE MANAGEMENT USE ONLY QA Review: Initial ______ Life # ______

Waste Category: LLW MW RCRA TSCA WASH ST DIS EPA Codes: ______

Packaging Category: Compactible Non-Compactible Pathological WAC Designation: ______

Hazard Class: Ignitable Corrosive Reactive Toxic Waste Stream Code: ______

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Send a question or comment to the SBMS Help Desk
Disclaimer

Radioactive Waste Inventory Form

See next page for instructions

RWCF # ___________________

Date	Article Description	Weight (pounds)	Volume, if liquid (gallons)	Radionuclide	μCi

Has any hazardous waste been introduced to this waste? ______________________

If "yes," please complete the Hazardous Waste Inventory Table below.

Hazardous Waste Inventory

Hazardous Component	Quantity

Comments: ____

Signature of Waste Generator: _________________________ Date: ____________________

Instructions for Completing the Radioactive and Hazardous Waste Inventory Sheet

This form must be used for the collection of any Radioactive or Mixed Waste.

Date:	**Write the date that the item was placed in the radioactive waste container.**
RWCF #:	**Fill in this line with the preprinted number from the corresponding Radioactive Waste Control Form.**
Article Description:	**Briefly describe the article placed in the container.**
Radionuclide:	**Indicate the radionuclide(s) involved. Can be either package summary or radionuclide for each article.**
μCi:	**Indicate the microcurie content. Can be either package total or curie content of each article.**
Hazardous Component:	**Describe any hazardous-waste component of the waste.**
Comments:	**Add anything that might be helpful in the proper characterization of the waste.**
Signature of Waste Generator:	**Signature of person responsible for generating the radioactive waste itemized on the Inventory Form. This signature serves to verify that the information given is complete and correct to the best of the waste generator's knowledge.**

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Definitions: Radioactive Waste Management

Effective Date: **August 2003**
Point of Contact: Radioactive Waste Program Manager

Term	Definition
Accountable Nuclear Material Waste Control Form (ANMWCF)	A Waste Management (WM) Program on-site waste shipping, tracking, and characterization document completed by waste generators for each container/package of radioactive or mixed waste (or for multiple containers/packages of the same waste) containing accountable material and used by WM to track radioactive and mixed waste containing accountable material from pickup to final disposition. ANMWCFs are orange and identified with unique, sequential serial numbers.
compactible waste	Items that are easily crushed in a compactor. Examples include paper; rags; clothing; respirators; empty glassware; easily crushable, empty, lightweight metal labware; and empty crushable plastic labware.
Container Custodian	A qualified generator or waste management individual responsible for maintaining control over waste containers while they are being filled and prior to sealing.
contingency storage	For off-normal or emergency situations involving high-activity or high-hazard Liquid Low-Level Radioactive Waste (LLLRW), spare capacity with adequate capabilities must be maintained to receive the largest volume of liquid contained in any one storage tank or container.
Decay In Storage (DIS)	Storage of radioactive waste for a period of time sufficient for radionuclide(s) of concern to be reduced in activity, by radioactive decay, to a level of lower concern. DIS must be consistent with the requirements of this subject area.
generator's certification statement	A statement signed by the waste generator on the Radioactive Waste Control Form (RWCF) or Accountable Nuclear Material Waste Control Form (ANMWCF) that says (or certifies) the waste meets the administrative, characterization, waste form, and packaging requirements defined within this subject area.
hazardous waste	A by-product of certain processes and activities that can pose a substantial or potential hazard to human health or the environment when improperly managed. Hazardous waste possesses at least one of four characteristics (ignitability, corrosivity, reactivity, and toxicity), or appears on special EPA lists.
industrial waste	[illegible]

industrial waste	Any liquid, gas, or solid waste resulting from an industrial process that may cause pollution. Industrial waste is not regulated as hazardous waste, but requires local or State approval for disposal to a landfill or resource recovery facility. Examples include nonhazardous waste oil, oil- spill debris, ion exchange resin columns, and nonfriable asbestos.
monthly	Once within a calendar month.
noncompactible waste	Items not suitable for compaction, including easily dispersed solids; unistrut sections; scrap metal; pressurized spray cans; and containers filled with a liquid or pressure reactive materials.
pollution prevention	The reduction or prevention of a hazardous or radioactive substance, pollutant, or contaminant from entering a waste stream or otherwise from being released to the environment before recycling or treatment.
radioactive material area	An area where the potential exists for contamination due to the presence of unencapsulated or unconfined radioactive material or an area that is exposed to beams or other sources of particles (neutrons, protons, etc.) capable of causing activation.
radioactive waste	Any garbage, refuse, sludges, and other discarded material, including solid, liquid, semisolid, or contained gaseous material that must be managed for its radioactive content. Any waste managed for its radioactive content that is not otherwise regulated for that radioactive content (e.g., waste released through permitted discharges to the environment). If a material was received as nonradioactive, any resulting waste is not a radioactive waste if it meets the following conditions: a. The waste contains no surface radioactivity above the limits established in DOE Orders or guidance (e.g., surface contamination limits and requirements of DOE Order 5400.5, *Radiation Protection of the Public and Environment*, Table II.5.c[1]) or successor documents; **And** b. The waste contains no measurable increase in radioactivity (at a statistically defined confidence interval) above background in volume or bulk resulting from BNL operations, as determined by the Radiological Controls Division's Facility Support Representative utilizing approved procedures. **Note:** Materials received as non-radioactive that may contain naturally occurring radioactivity (e.g., refractory brick, diatomaceous earth, or kitty litter) may be disposed of as nonradioactive waste providing the radioactivity has not been concentrated or enhanced by BNL operations, as determined by implementation of approved BNL procedures, and it has been approved for release.
radioactive waste accumulation area	An area designated by the Department/Division as the central accumulation point for any radioactive wastes awaiting pickup. Each Radioactive Waste Accumulation Area must be established where it

	is convenient for the Department/Division and consistent with the requirements of this subject area.
Radioactive Waste Accumulation Area Manager	A person appointed by the Department/Division to control and oversee the day-to-day operations of one or more of the Department/Division's Radioactive Waste Accumulation Area(s).
radioactive waste classification	Term used to describe the different classes of radioactive waste, as defined below: **Low-Level Radioactive Waste (LLRW)** is radioactive waste not classified as high-level waste, transuranic (TRU) waste, spent nuclear fuel, or by-product material as defined below. **Mixed Waste** is LLRW that also contains hazardous waste. See the Mixed Waste Management Subject Area for further details. **By-product material** is categorized as either: 1. Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to radiation incident to the process of producing or using special nuclear material; **or** 2. The tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. **High-level waste** is the highly radioactive waste material that results from the reprocessing of spent nuclear fuel, containing a combination of transuranic waste and fission products in quantities requiring permanent isolation or other materials determined to require permanent isolation. It includes liquid waste produced directly in reprocessing and any solid waste derived from the liquid. **Note:** Waste Management (WM) is **not** approved to dispose of high-level waste. Special arrangements must be made prior to generation. **Accountable Nuclear Material/Waste** is waste containing depleted, normal, and enriched uranium, U-233, plutonium, Am-241, Am-243, Cm, Cf-252, Bk-249, Np-237, Li-6, thorium, tritium gas, and deuterium as heavy water.
Radioactive Waste Control Form (RWCF)	A Waste Management (WM) Program on-site waste shipping, tracking, and characterization document completed by waste generators for each container/package (or group of similar packages) of radioactive or mixed waste, and used by WM to track the waste from pickup to final disposition. RWCFs are identified with unique, sequential serial numbers.
Radioactive Waste	A form used by the waste generator to record additions of

Inventory Form	radioactive waste to each package at the point of generation.
segregation	The process of separating, or keeping separate, individual waste types and forms in order to facilitate their cost-effective treatment, storage, and disposal.
short half-life isotopes	Isotopes with a half-life less than 90 days.
source material	Depleted uranium, normal uranium, thorium, or any other nuclear material determined, pursuant to Section 61 of the Atomic Energy Act of 1954, as amended, to be source material; or ores containing one or more of the foregoing materials in such concentration as may be determined by regulation.
Special Nuclear Material (SNM)	Plutonium, uranium-233, uranium enriched in the isotope 235, and any other material that, pursuant to Section 51 of the Atomic Energy Act of 1954, as amended, has been determined to be SNM, not including source material; it also includes any material artificially enriched by any of the foregoing, not including source material.
staging	Storing waste (<90 days) for the purpose of accumulation to facilitate transportation transfer, treatment, and/or disposal.
State Regulated Low Level Radioactive Waste (LLRW)	LLRW contaminated with substances regulated by the State where the off-site disposal facility is located. For the purposes of this standard, LLRW contaminated with oils, chelating compounds, organic solvents, halogenated organics, polycyclic aromatic hydrocarbons, carcinogens, mutagens, or toxic compounds constitutes State Regulated LLRW. State Regulated LLRW may be stored in a Radioactive Waste Accumulation Area as long as it is segregated from regular LLRW by means of a physical barrier (e.g., wall) or is held in a partitioned area (e.g., floor taped to show separation). For further information on State Regulated LLRW, contact the Environmental Subject Matter Expert.
storage	The holding of radioactive waste for a temporary period, at the end of which the waste is treated, disposed of, or stored elsewhere.
transuranic (TRU) waste	Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.
treatment	Any method, technique, or process designed to change the physical or chemical character of waste to render it less hazardous; safer to transport, store, or dispose of; or reduce its volume.
treatment, storage, or disposal facilities (TSDF)	An approved facility for the treatment, storage, or disposal of radioactive, mixed, or hazardous waste.
waste acceptance criteria (WAC)	Waste acceptance criteria are the technical and administrative

(WAC)	requirements that a waste must meet in order for it to be accepted at a storage, treatment, or disposal facility.
waste characterization	The identification of waste composition and properties, by review of acceptable knowledge (which includes process knowledge), or by nondestructive examination, nondestructive assay, or sampling and analysis, to comply with applicable storage, treatment, handling, transportation, and disposal requirements.
waste certification	A process by which Waste Management (WM) affirms that a given waste or waste stream meets the waste acceptance criteria of the off-site facility to which the waste will be transferred. WM is responsible for certification of all BNL radioactive wastes for offsite transfer for treatment, storage, or disposal, in accordance with requirements of the BNL Waste Certification Program Plan in the Radioactive Waste Management Basis Program Description.
waste generator	Any person whose activity at BNL produces radioactive waste or other wastes managed by the Waste Management Program.
waste minimization	A waste-management approach that focuses on preventing or reducing the generation of pollutants, contaminants, or wastes at the source.
waste packager verifier	A qualified WM individual responsible for independently verifying that an approved waste container and packaging materials are used for packaging waste, and that the contents of a waste package are properly documented by the waste generator and are consistent with the applicable waste acceptance requirements.

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Revision History: Radioactive Waste Management

Point of Contact: Radioactive Waste Program Manager

Revision History of this Subject Area

Date	Description	Management System
August 2003	The subject area was revised to include corrective actions identified in the DOE O 435.1, *Radioactive Waste Management* Assessment conducted in May 2002. These include the following • Characterization methodologies; • Staging and storage requirements; • Contingency storage applicability; • Waste acceptance criteria; • Waste certification. The reference to the Low-Level Waste Certification Program Plan (LLWCPP) was replaced with the Waste Certification Program Plan (WCPP) in the Radioactive Waste Management Basis Program Description. The reference to the revised Radioactive Waste Management Basis (RWMB) for Brookhaven National Laboratory document was modified to reflect its new location in the Radioactive Waste Management Basis Program Description. The section Waste Certification was revised to clarify the term "certification" for on-site and off-site waste transfers. A new section Processing Radioactive Liquid Waste was added to include updated waste acceptance criteria (WAC) for treatment, storage, and disposal facilities (TSDFs)	Environmental Management System

	storage, and disposal facilities (TSDFs). The definition of "Radioactive Waste" was appended to include the definition from DOE O 435.1, *Radioactive Waste Management*. Definitions for "staging," "storage," "transuranic (TRU) waste," and "treatment" were added. The definition for "certification statement" was modified to "generator's certification statement."	
February 2002	The Contents section was revised to add a reference to the BNL Low-Level Waste Certification Program Plan (LLWCPP). The Introduction section was revised to include BNL's compliance with DOE Order 435.1 in accordance with the DOE-approved Radioactive Waste Management Basis (RWMB) document. The Generating Waste section was revised to include the following requirements: • Wastes that are packaged by the waste generator require point of generation inspection by the Waste Management Division. • Final waste loads must have an even load distribution. References to the Low-Level Waste Certification Program Plan (LLWCPP) and the Radioactive Waste Management Basis (RWMB) were added to the section. The "Radioactive Liquid Waste Acceptance Criteria" exhibit was updated to better define activity levels for specific radioactive materials. The Completion of the Waste Control Form section was revised to include the following requirements: • Waste weights are to be recorded in grams or hundredths of a pound for light, higher activity items	Environmental Management System

	hundredths of a pound for light, higher activity items (weighing less than 1 lb.). • The identification of elemental zinc if TCLP is required. A reference to the new "Low-Level Waste Generator Characterization Guidance" exhibit was added to the subject area and referenced in the section. The Operating a Radioactive Waste Accumulation Area section was revised to document the DOE Order 435.1 requirement that waste not be staged longer than 90 days. The Waste Certification section was revised to remove the sentence stating that all radioactive waste is transferred to the Waste Management Facility. The word "hazardous" was changed to "radioactive" and the acronym "TSDF" was added to explain the off-site transfer of waste to treatment, storage, or disposal facilities. The Low-Level Waste Certification Program Plan (LLWCPP) and Exemption Request for Use of Non-DOE LLW Disposal Facility form were added as references. The Definitions section was revised to include a reference to the Low-Level Waste Certification Program Plan (LLWCPP) in the definition for "waste certification." The definitions for the "Accountable Nuclear Material Waste Control Form (ANMWCF)" and the "Radioactive Waste Control Form (RWCF)" were modified to be consistent with the WMD-SOP-510 definition. A definition was added for "treatment, storage, or disposal facilities (TSDF)."	
December 2000	The Waste Certification section was added to the subject area to clarify the responsibility of the Waste Management Division for certifying all BNL radioactive wastes prior to offsite transfer for treatment, storage, or disposal. The following terms were added to the Definitions section: "certification statement," "waste acceptance criteria," "waste characterization," and "waste certification." The Point of Contact for the subject area sections was updated.	Environmental Management System
December 1999	The "Prohibited Articles in Radioactive Solid Waste Packages" sign was provided as a downloadable exhibit in Section 3, Establishing a Radioactive Waste Accumulation Area.	Environmental Management System
March 1999	This subject area replaces ES&H Standard 6.2.2.	Environmental Management

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