



**LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT
PROGRAM BASIS DOCUMENT**

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INTRODUCTION

The purpose of this document is to describe the Radioactive Waste Management Basis outlining the Princeton Plasma Physics Laboratory (PPPL) radioactive waste program as a generator of radioactive material for eventual characterization, packaging, transportation and disposal at an off-site DOE approved facility. This document summarizes the conditions under which the facility may operate based on the radioactive waste management documentation. The program requirements and operational procedures described herein apply to PPPL personnel who are responsible to develop and implement Low Level Radioactive Waste (LLW) plans and procedures in accordance with DOE M 435.1-1 Chapter IV and applicable federal and state regulations. PPPL does not generate high level, transuranic, or mixed radioactive waste.

PPPL is a DOE national science laboratory managed by Princeton University under contract to DOE. Its mission is to conduct scientific research into plasma physics and to develop and demonstrate the practical application of fusion power as an alternative energy source. PPPL is located on Princeton University's James Forrestal Campus in Plainsboro Township, Middlesex County, New Jersey, and has operated on the current site since 1959.

The radioactive waste management program at PPPL is operated by the Environmental Services Division (ESD) in the Environment, Safety &, Health (ES&H) Department. Radiological protection, monitoring and characterization support is provided by the Health Physics (HP) Division, which is also part of ES&H.

APPLICABLE REQUIREMENTS & IMPLEMENTING PROCEDURES

General Program Requirements

PPPL's LLW program is coordinated with other management programs/systems that address laboratory conduct of operations, environment, safety, health and security. The applicable general operational requirements from Chapter I, Section 1, E of DOE Manual M435.1 and key PPPL implementing documents are summarized in the table below. Further details regarding each of these programs are not discussed in this document but can be found in the applicable PPPL implementing document.

Applicable Requirement	PPPL Implementing Documents
(1) Analysis of Operations Information	Radiation Protection Plan, Environmental Monitoring Plan
(3) Conduct of Operations	Policy P-006, ESHD 5008 Section 11, Procedures ENG-055, ENG-030, ENG-032 and OP-AD-39
(5) Emergency Management Program	Emergency Preparedness Plan, Continuity of Operations Plan, and implementing procedures

Applicable Requirement	PPPL Implementing Documents
(6) Environmental and Occurrence Reporting	Policy P-003, Procedures GEN-004, GEN-006, GEN-011 and ESH-013
(7) Environmental Monitoring	Environmental Monitoring Plan and implementing procedures
(8) Hazards Analysis Documentation and Authorization Basis	Policy P-048, ESHD 5008 Section 11 Chapter 1, Procedure ESH-014
(9) Life-Cycle Asset Management	Policies P-010, P-077, Procedures GEN-009, ENG-005, ENG-032 and ENG-052
(11) Packaging & Transportation	PPPL On-Site Transportation Safety Plan, Procedures EM-OP-06 and EM-OP-07
(12) Quality Assurance Program	Policy P-004, Institutional QA Plan (EQP-004), Procedures QA-002 through QA-025, EM-QA-01, EM-QA-20, EM-AD-19
(13) Radiation Protection	Policy P-027, Radiation ALARA Plan, Radiation Protection Plan and implementing procedures, ESHD 5008 Section 10, Environmental Monitoring Plan
(14) Records Management	Policy P-015, Procedure GEN-023 and EM-OP-15
(15) Release of Waste Containing Residual Radioactive Material	Policy P-089, Moratorium on the Release of Surplus and Scrap Materials; Procedure ESH-024, Management of Moratorium and Suspension Encumbered Metals
(16) Safeguards & Security	Nuclear Material Control and Accountability (NMC&A) Plan and implementing procedures
(17) Safety Management System	Policies P-003, Integrated Safety Management System Description and implementing procedures
(18) Site Evaluation and Facility Design	Procedure ESH-025, Operations Hazard Classification Criteria and Safety Certification System
(19) Training and Qualification	Policy P-008, Procedures TR-001, TR-005, TR-006, TR-007, EM-TR-01 and EM-TR-17

Applicable Requirement	PPPL Implementing Documents
(20) Waste Minimization	Policy P-014, Procedures EM-CP-21, EM-OP-07 and EM-OP-09
(21) Worker Protection	Policies P-003 and P-012, PPPL Worker Safety & Health Program Plan and implementing procedures

Low Level Radioactive Waste (LLW) Management Program Requirements

This section summarizes PPPL implementation of the applicable LLW management requirements from Chapter IV of DOE Manual M453.1

Note: Regular text refers to requirements from DOE Order 435.1, Contractor Requirements Document (CRD), or Chapter IV of Manual M435.1. Text in *italics* is from DOE Guide G435.1. Text shown in **bold** describes the PPPL program or procedure meeting the DOE requirements.

Chapter IV – Low Level Waste Requirements

The sections A, B, C, D, E, F, delineate the various possibilities for a radioactive waste program to encompass. The PPPL program provides for the generation, storage, and disposal of radioactive material as low-level radioactive waste. PPPL does not generate or manage mixed waste, TSCA-regulated LLW, accelerator produced waste, or byproduct/naturally occurring radioactive material. We also do not treat or dispose of any waste on-site. PPPL does not process or handle any high activity or high hazard liquid low level waste. Corrective actions and or operations curtailment, such as “stop work” are accomplished through established PPPL policies and procedures.

G. Waste Acceptance: The requirements for approval to ship and ultimately dispose of low-level radioactive waste at a DOE approved disposal facility is accomplished through the submittal of waste profiles to the disposal facilities according to their waste acceptance criteria according to their license(s). The profiles describe the physical and chemical form, container requirements, long-term stability, and restrictions such as: free liquids, void space, chemical constituents, flammability, decomposition, gas generation, vapors, fumes, and other restrictions/hazards deleterious to land burial. In addition to waste profiles, burial facilities may review policies and procedures related to Quality Assurance and specific waste packaging described in the remainder of this document. Formal approval from the burial facility is required prior to initiating the packaging and subsequent transportation and disposal of low-level radioactive waste from PPPL.

H. Waste Generation Planning: PPPL does not generate LLW without a path to disposal. This is prevented using the NEPA process, our Environmental Management System and our Work Planning System. A new process is not permitted to occur without approval. If the process has the potential to generate a waste form that is not acceptable to existing waste acceptance,

the process cannot be initiated. If the process is of high value or importance to the mission of the laboratory, waste acceptance approval will be obtained prior to initiation of the new process. PPPL generates one type of radioactive waste stream identified as “low-level radioactive waste”. The life cycle of this waste is well known. The material is either contaminated or activated by research operations and it can exist in liquid or solid form. Liquids are solidified/stabilized to a solid state and all solids are packaged in accordance with DOT and burial facility regulations and acceptance criteria. Interim storage of materials is permitted, but ultimately all materials are reused at PPPL, released for unrestricted use, or shipped for disposal as outlined in Procedure ESH-024.

- I. Waste Characterization - Low-level waste shall be characterized using direct or indirect methods, and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance requirements of the facility receiving the waste.

The Environmental Services Division (ESD) of the Environment, Safety and Health, (ES&H) Department has functional responsibilities for waste, which include arranging for the removal, characterization, packaging, and disposition of waste generated. Compliance with this requirement is demonstrated by a program for documenting, and the existence of records that document the process for acquiring and verifying the validity of low-level waste characterization data acquired through the use of direct or indirect methods. Procedure OP-AD-115, “Movement of Radioactive/Contaminated Material To/From D-site” specifies the process for a PPPL waste generator to identify, characterize and transfer the waste to ESD and movement of that material to the Radioactive Waste Handling Facility (RWHF). Procedure EM-OP-09, “Radioactive Waste Characterization” provides for the indirect and direct methods of waste characterization. The actual characterization is performed by the Health Physics Division using operational procedures for liquid scintillation counting, beta-gamma measurements, and gamma spectroscopy, as applicable. These procedures are as follows: HP-OP-04 - “Surface Contamination Surveys”, HP-OP-05 - “Radiation Dose Rate Measurement Surveys, and HP-OP-09 – “Radiological Survey and Monitoring Records”.

- (1) Data Quality Objectives. The data quality objectives process, or a comparable process, shall be used for identifying characterization parameters and acceptable uncertainty in characterization data.

Compliance with this requirement is demonstrated by the documented use of a data quality objectives or a comparable process for determining the type, quantity, and quality of characterization data needed to safely manage low-level waste. Radioactive waste management facilities characterize waste in accordance with the requirements of the receiving storage, treatment, or disposal facility.

Waste profiles are submitted by PPPL to the waste disposal facility for approval. These profiles identify the parameters and protocols to provide characterization and packaging of the material in accordance with the profile and disposal facility requirements. PPPL health physics procedures identify methods and parameters

for radiological surveys in support of EM-OP-09. EM-CP-21, the “Low Level Radioactive and Mixed Waste Certification Plan” provides programmatic management oversight. EM-QA-20 – “Quality Assurance Program – Low Level Radioactive Waste and Mixed Waste” outlines the quality assurance requirements of PPPL’s LLW management program.

- (2) Minimum Waste Characterization. Characterization data shall, at a minimum, include the following information relevant to the management of the waste: a) Physical and chemical characteristics. (b) Volume, including the waste and any stabilization or absorbent media; (c) Weight of the container and contents; (d) Identities, activities, and concentrations of major radionuclides; (e) Characterization date; (f) Generating source; and (g) Any other information which may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with applicable performance objectives.

Attachment 1 of OP-AD-115 (attached as Exhibit A) provides the form to document all of the information stated above for the item(s) of radioactive material or waste that is generated and transferred to ESD for processing. When the item(s) are packaged, additional parameters are applied and documented in accordance with the “Container Inventory Sheet” (Exhibit B) of EM-OP-07 – “Solid Radioactive Waste Packaging”.

- J. Waste Certification - A waste certification program shall be developed, documented, and implemented to ensure that the waste acceptance requirements of facilities receiving low-level waste for storage, treatment, and disposal are met.

Procedure EM-CP-21, “Low Level Radioactive and Mixed Waste Certification Plan” provides for waste certification. This procedure outlines the requirements for, and identifies the officials responsible for, certification of LLW for disposal. Procedure EM-TR-17, “Waste Management Technician and Engineer Qualification” requires waste technical specialists and waste engineers to complete the appropriate training/qualification before being granted approval to perform any waste operations. Approved waste profiles are necessary to generate and package waste for transportation.

- (1) Certification Program. The waste certification program shall designate the officials who have the authority to certify and release waste for shipment; and specify what documentation is required for waste generation, characterization, shipment, and certification. The program shall provide requirements for auditability, retrievability, and storage of required documentation and specify the records retention period.

Compliance with this requirement is demonstrated by a program or procedure for record keeping and records showing that low-level waste is certified as having met the waste acceptance criteria of the facility to which it was transferred and that the

certification statement is supported by additional records regarding the waste source, characterization, and container.

In addition to EM-CP-21, procedures EM-OP-07, “Solid Radioactive Waste Packaging,” EM-OP-15, “Records Management,” and EM-OP-06, “Off Site Shipments of Hazardous, Radioactive, Mixed and Non-Regulated Waste” fulfill this requirement.

- (2) Certification before Transfer. Low-level waste shall be certified as meeting waste acceptance requirements before it is transferred to the facility receiving the waste.

Compliance with this requirement is demonstrated by the presence of a certification program which includes procedures requiring a signed certification statement prior to the release of waste for transfer, and by dated records showing that waste was certified before being transferred.

In addition to the requirements of EM-CP-21, procedures EM-OP-07, “Solid Radioactive Waste Packaging” and EM-OP-06, “Off Site Shipments of Hazardous, Radioactive, Mixed and Non-Regulated Waste” provide for the certification of waste before transfer. Procedure OP-AD-115 provides the documentation of the item(s) from point of generation through the packaging in a waste container.

- (3) Maintaining Certification. Low-level waste that has been certified as meeting the waste acceptance requirements for transfer to a storage, treatment, or disposal facility shall be managed in a manner that maintains its certification status.

Compliance with this requirement is demonstrated by a program or procedure reflecting this requirement is present and site personnel are able to show that the storage of low-level waste containers is in a facility or manner where the containers would not be damaged by normal weather events, and cannot be accessed by unauthorized personnel. Further, each container can be traced to its certification and the information supporting that certification radioactive material.

Procedure EM-CP-21, “Low Level Radioactive and Mixed Waste Certification Plan” provides for waste certification. Procedures EM-OP-07, “Solid Radioactive Waste Packaging” and EM-OP-06, “Off Site Shipments of Hazardous, Radioactive, Mixed and Non-Regulated Waste” fulfill this requirement. Procedure OP-AD-115 provides the documentation of the item(s) from point of generation through the packaging in a waste container. All radioactive waste requiring packaging is stored in the RWHF which has badge-controlled access. This building has 18” thick walls and is completely enclosed and climate controlled.

- K. Waste Transfer - A documented process shall be established and implemented for transferring responsibility for management of low-level waste and for ensuring availability

of relevant data. The following requirements are in addition to those in Chapter I of this Manual.

Compliance with this requirement is demonstrated if facilities have procedures for the receipt of waste and the transfer of waste, as appropriate, which address the acquisition of waste and container data and the transfer of ownership, respectively. Further evidence of acceptable performance is facility records showing that data on the waste containers is available and accurate, and that documented transfer of responsibility occurs.

Procedures OP-AD-115, EM-OP-06, and EM-OP-07 address these requirements.

- (1) Authorization. Low-level waste shall not be transferred to a storage, treatment, or disposal facility until personnel responsible for the facility receiving the waste authorize the transfer.

From DOE G 435.1-1 Chapter IV: Compliance with this requirement is demonstrated by sites having procedures that require a confirmation of authorization before releasing waste for transfer, and records showing that transfers are made in accordance with written authorizations.

Procedure OP-AD-115, “Movement of Radioactive/Contaminated Material To/From D-site” specifies the process for a PPPL waste generator to begin the process for identification, characterization and transfer of the waste to ESD for storage and processing in the RWHF. Release of waste for disposal is governed by EM-OP-06 and EM-OP-07.

- (2) Data. Waste characterization data, container information, and generation, storage, treatment and transportation information for low-level waste shall be transferred with or be traceable to the waste.

From DOE G 435.1-1 Chapter IV: Compliance with this requirement is demonstrated if there are procedures requiring that characterization and container data be provided and maintained for each low-level waste transfer and documented records of transfers show that the information is being provided.

Procedure OP-AD-115, “Movement of Radioactive/Contaminated Material To/From D-site” governs the process for a PPPL waste generator to begin the process for identification, characterization and transfer of the waste to ESD for storage and processing in the RWHF. Procedure EM-OP-09, “Radioactive Waste Characterization” provides for the indirect and direct methods. Procedures EM-OP-07, “Solid Radioactive Waste Packaging” documents the processing of each waste container prepared for burial.

L. Packaging and Transportation.

From DOE G 435.1-1 Chapter IV: Compliance with the packaging requirement is demonstrated by: (1) procedures which document proper packaging protocols; and (2) no trends of routine repackaging of low-level waste that is packaged after issuance of DOE O 435.1. Successful performance of this requirement is also demonstrated by a record of containers for which failure has not routinely occurred under management conditions. It is recognized that there may be failed containers for waste previously placed in storage. For those containers, the goal is to only have to repackage the waste one time after it is retrieved and characterized. Further, acceptable performance is demonstrated by containers of waste having marking and labeling that allows correlation with waste characterization data and container information.

(1) Packaging. If containers are used:

- (a) Low-level waste shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container.

Procedures OP-AD-115 and EM-OP-07 control the waste handling process from point of generation to final packaging. All radioactive waste requiring containers is stored in the RWHF which is equipped with badge access controls. This building has 18” thick walls and is completely enclosed and climate controlled.

- (b) When waste is packaged, vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.

PPPL waste is packaged in containers specifically designed to contain tritium, which can be in the oxide and gaseous form. Therefore, the containers do not have a vent. If a vent were included the tritium could escape the container to the environment. The strength of the container is designed to contain the pressure transients due to temperature change without venting by utilizing additional structure, in accordance with 49 CFR 173. Flammable or explosive concentrations are not possible due to exclusion of these items from waste packages.

- (c) Containers of low-level waste shall be marked such that their contents can be identified.

The marking and labeling of packages is addressed by procedure EM-OP-07 and EM-OP-06, “Off site Shipments of Hazardous, Radioactive, Mixed and Non-Regulated Waste”.

- (2) Transportation. To the extent practical, the volume of waste and number of low-level waste shipments shall be minimized.

From DOE G 435.1-1 Chapter IV: Compliance with this requirement can be demonstrated by a combination of site procedures directing the efficient use of waste container capacity and documentation showing that low-level waste shipments are systematically planned and optimized to the extent practical.

The waste engineers coordinate with packaging and transportation personnel for waste shipped offsite from this facility using procedures OP-AD-115 and EM-OP-07. The Radiation Work Permit for all radiological areas specifically directs personnel not to use hazardous materials in a radiologically controlled area and also addresses waste minimization. PPPL's Radiation Safety Training includes information on radioactive waste minimization and the prohibition on use of hazardous materials in radiologically controlled areas. Procedural requirements and employee training programs ensure that PPPL complies with this requirement. They also ensure no waste will be packaged which will chemically react with the packaging material to compromise the package integrity. Compactable waste is used to the maximum extent practical to fill all void spaces within containers. This practice significantly reduces the need to process compactable waste in drums and the need for void space filler in larger waste containers.

PPPL POLICIES AND PROCEDURES FOR RADIOACTIVE WASTE MANAGEMENT

EM-CP-21, "Low-level Radioactive and Mixed Waste Certification Plan"
EM-OP-06, "Off-site Shipments of Hazardous, Radioactive, Mixed, and Non-Regulated Wastes"
EM-OP-07, "Solid Radioactive Waste Packaging"
EM-OP-09, "Radioactive Waste Characterization"
EM-OP-15, "Waste Management Records"
EM-OP-27, "Glass Crusher Operation"
EM-OP-28, "Liquid Radioactive Waste Packaging"
EM-OP-32, "Packaging the NUHIC-55 High Integrity Container"
EM-OP-33, "Rain Water Sampling"
EM-OP-39, "Non-Destructive Analysis Using Gamma Spectroscopy"
EM-QA-20, "Quality Assurance Program Plan, Low Level Radioactive Waste & Mixed Waste"
EM-TR-17, "Waste Management Technician and Engineer Qualification"
OP-AD-115, "Movement of Radioactive/Contaminated Material To/From D-site"
HP-OP-04, "Surface Contamination Surveys"
HP-OP-05, "Radiation Dose Rate Measurement Surveys"
HP-OP-09, "Radiological Survey and Monitoring Records"

ATTACHMENTS

Exhibit A – Attachment 1 of OP-AD-115, "Material Transfer Sheet"
Exhibit B – Attachment 2 of EM-OP-07, "Container Inventory Sheet"