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Characterization, Minimization and Disposal of Radioactive, Hazardous, and Mixed Wastes During Cleanup and Transition of the Tritium Research Laboratory (TRL) at Sandia National Laboratories/California (SNL/CA)

Toff B. Garcia, Thomas P. Gorman

Prepared by
Sandia National Laboratories
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CHARACTERIZATION, MINIMIZATION AND DISPOSAL OF
RADIOACTIVE HAZARDOUS, AND MIXED WASTES DURING CLEANUP
AND TRANSITION OF THE TRITIUM RESEARCH LABORATORY (TRL)
AT SANDIA NATIONAL LABORATORIES/CALIFORNIA (SNL/CA)

TOFF B. GARCIA
THOMAS P. GORMAN

Sandia National Laboratories/California

ABSTRACT

This document provides an outline of waste handling practices used during the Sandia National Laboratory/California (SNL/CA), Tritium Research Laboratory (TRL) Cleanup and Transition project. Here we provide background information concerning the history of the TRL and the types of operations that generated the waste. Listed are applicable SNL/CA site-wide and TRL local waste handling related procedures. We describe personnel training practices and outline methods of handling and disposal of compactible and non-compactible low level waste, solidified waste water, hazardous wastes and mixed wastes. Waste minimization, reapplication and recycling practices are discussed. Finally, we provide a description of the process followed to remove the highly contaminated decontamination systems. This document is intended as both a historical record and as a reference to other facilities who may be involved in similar work.

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ACRONYMS

ALARA	as low as reasonably achievable
BAAQMD	Bay Area Air Quality Management District
CWS	Chilled Water System
DOE	Department of Energy
EPA	Environmental Protection Agency
EPS	Emergency Power Systems
ES&H	Environment, Safety and Health
GERT	General Employee Radiological Training
GPS	Gas Purification System
HPS	Health Physics Society
HTO	Tritium Oxide
HVAH	High Velocity Air Hood System
ICRP	International Commission for Radiation Protection
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LNS	Liquid Nitrogen System
LSA	Low Specific Activity
NCRP	National Council on Radiation Protection and Measurements
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NMR	Nuclear Magnetic Resonance
NTS	Nevada Test Site
OBT	Organically Bound Tritium
PVT	Pressure Volume Temperature
RCP	Radiological Characterization Plan
RMMA	Radiological Materials Management Area
RR&FFSR	Radiological Characterization and Final Facility Status Report
SNL/CA	Sandia National Laboratories/California
SWP	Safe Work Permit
TEM	Transmission Electron Microscope
T ₂	Tritium Gas
TRL	Tritium Research Laboratory
UPS	Uninterruptible Power Supply
VERS	Vacuum Effluent Recovery System
WWES	Waste Water Evaporator System
WWRS	Waste Water Recovery System

CHARACTERIZATION, MINIMIZATION AND DISPOSAL OF RADIOACTIVE HAZARDOUS, AND MIXED WASTES DURING CLEANUP AND TRANSITION OF THE TRITIUM RESEARCH LABORATORY (TRL) AT SANDIA NATIONAL LABORATORIES/CALIFORNIA (SNL/CA)

Introduction

From January, 1992 through October, 1996, the Tritium Research Laboratory (TRL) at Sandia National Laboratory, California (SNL/CA) underwent a Cleanup and Transition project resulting in a transition in operations from a Category II non-reactor nuclear facility to a low hazard general purpose laboratory, now known as the Chemical and Radiation Detection Laboratory (CRDL). This transition involved an extensive cleanup operation, resulting in a substantial waste handling and disposal effort, including eight shipments of low-level radioactive waste, totaling 78.9 m³ by volume and 80,129 Ci of activity, for burial at the Nevada Test site between June, 1993 and April, 1996.

This document provides an outline of waste-handling practices and procedures used during the TRL Cleanup and Transition project as both a historical record and a reference to other facilities involved in similar work. Additional detailed information, including a TRL Effluent Flow Chart, shipment history, Process Knowledge Evaluation Forms and applicable excerpts from the SNL/CA Low-Level Waste Management Plan are included in the Waste Packaging and Waste Disposal Report provided as an attachment to this report.

TRL Background Information

Sandia National Laboratory, California (SNL/CA) is located about 70 km east of San Francisco, in eastern Alameda County, at the southeast end of the Livermore Valley. The approximately 413 acre site is roughly 5 km east of downtown Livermore.

Sandia designed the Tritium Research Laboratory (TRL) as a modern research and development facility to provide support to the DOE weapons complex. Sandia completed construction of the basic laboratory building during the summer of 1975, and began initial testing with limited quantities of tritium in November of 1976. Following these initial tests, they completed the Gas Purification System (GPS), the Vacuum Effluent Recovery System (VERS), and the monitoring systems and tested them during the first half of 1977, attaining operational status in late 1978. In 1984, Sandia added a separate office building to the complex, and in 1985 made extensive seismic upgrade modifications on the laboratory building and exhaust system.

The TRL was the first major tritium research and development complex to use secondary containment coupled with a cleanup system as a means to control personnel exposure to levels as low as reasonably achievable (ALARA) and reduce environmental releases. The TRL complex included Laboratory Building 968, Office

Building 967, an equipment room, Storage Building 969, a Liquid Effluent Control System (LECS), and an exhaust stack.

Cleanup and Transition of the TRL

In January of 1992, Sandia and the Department of Energy (DOE), Kirtland Area Office (KAO) agreed to cease tritium operations at the TRL. Sandia based this decision on increased operating costs as a result of projected costs associated with regulatory compliance and the availability of similar facilities at other sites. To study requirements and plan activities associated with carrying out this cessation of tritium operations, Sandia formed the TRL Cleanup and Transition Team. The goal of this team was to cease tritium operations at the California site and to continue to manage the TRL facility through the facility's transition to some other application. To achieve this goal, the team identified the following objectives:

- bring accountable tritium inventory to zero
- transfer operational experiments to other facilities
- reallocate excess equipment
- determine remaining tritium level

These objectives involved continuing operation of the TRL, while preparing (cleaning up) the facility for transition operations.

- cleanup, remove and/or reallocate non-safety related excess equipment
- obtain DOE approval to transition from a Category III Nuclear Facility to a Radiological Facility
- cleanup, remove and/or reallocate safety related equipment
- Characterize the SNL/CA Building 968 complex
- transfer transition technology

These objectives involved cessation of operation of the TRL and preparing the facility for other applications.

The TRL Cleanup and Transition Team was subsequently split into two separate teams: the Cleanup Team and the Transition Team. The charters and plans for each of these teams, along with the detailed plan developed and carried out by each of these teams, are included in the appendices of this document.

Characteristics of Tritium

Tritium, with a half-life of 12.35 years (NCRP 1985), is a radioactive isotope of hydrogen. With an atomic number of 1 and an atomic weight of 3, tritium decays with an emission of an electron to form Helium-3. The average energy of the

electron emitted from the decay is 5.6 keV with a maximum energy of 18.6 keV. At the maximum energy, its track length is 6 micrometers in water, and is insufficient to penetrate human skin, making it an internal hazard only. This fact also shows that traditional methods for personnel dose assessment such as; film badges, thermoluminescent dosimeters, or pocket ionization chambers are inefficient for detection of tritium in the body, and bioassay of bodily fluids using liquid scintillation counting is the best means for detection. There are three main pathways in which tritiated water can incorporate into the human body: 1) through the lungs by respiration, 2) ingested orally and absorbed through gastrointestinal tract, and 3) absorbed through the skin. Tritium remains in the body in the forms of tritiated water and organically bound tritium (OBT). Tritiated water is eliminated from the body with a biological half-life of 9.7 days, and OBT with half-lives of 30 and 450 days.

Tritium physical and chemical characteristics are nearly identical to hydrogen. Tritium gas burns in oxygen to form tritiated water. It can and readily does exchange with hydrogen atoms of organic compounds. Tritium gas can diffuse through almost any container regardless of its material.

Tritium has unique characteristics that provide unusual challenges for dosimetry and health risk assessment. For additional information on tritium and its effects, there are many papers and journals available for review. Recommended is the recent Health Physics Journal, Special Issue; Vol. 65, No. 6, December 1993, titled, "Tritium Dosimetry, Health Risks, and the Environmental Fate."

TRL Operations Overview

The TRL complex was used to support operations related to weapons development, component functional testing, engineering design, and applied materials research. Due to changing requirements, the TRL's mission varied over the years, but generally were centered around three major goals:

- Examining the behavior of hydrogen isotopes and helium in metals to understand transport and structural properties.
- Examining tritium and its compounds to understand their physical and chemical behaviors.
- Formulate and fabricate tritium compounds for engineering components.

Over the past approximately 18 years, the TRL complex accomplished its mission using a wide range of state-of-the-art equipment to perform diverse operations. The operations conducted in support of its mission were dynamic and include the following categories:

Sample Preparation

Instrument Operation and Maintenance

Scanning Electron Microscopy

Transmission Electron Microscopy
Auger Spectrometry
Nuclear Magnetic Resonance
Light Isotope Mass Spectrometry
Constant-Heat-Flow Calorimetry
Helium-in-Metals Mass Spectrometry
Tritium Assay/Accountability and Control
Tritium Contaminated Waste Handling, Packaging, and Disposal
High Pressure Tritium Pumping
System and Component Functional Testing
Tritium Permeation and Diffusion Research
Tritium Charging of Tensile Bars at High Pressure and Temperature
Research on First-Wall Fusion-Reactor Materials
Research on Tritium Solubility in Metals

TRL Waste Handling Procedures

Stringent laws and regulations govern the generation, handling, and disposal of hazardous, radioactive and mixed wastes. During the TRL Cleanup and Transition project, the primary laws regulating these issues were set forth at the federal level in the following documents:

- U.S. Environmental Protection Agency (EPA), Title 40 CFR, Parts 260-268, Resource Conservation and Recovery Act (RCRA)
- U.S. EPA, Title 40 CFR, Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs)
- U.S. Congress, Clean Air Act Amendment of 1990, specifically the National Ambient Air Quality Standards (NAAQSs).

Further federal regulation was set forth in several Department of Energy Orders including DOE Orders 1540.2, 5400.1, 5400.2A, 5400.3, 5480.1B, 5480.3, 5480.4, 5482.1B, 5820.2A.

At the State level, the handling of hazardous, radioactive and mixed wastes was governed by regulations set forth in:

- State of California, Title 22, California Code of Regulations (CCR), Division 4.5, *Environmental Health Standards for the Management of Hazardous waste*.

Local regulations affecting TRL waste handling operations were contained in:

- City of Livermore Municipal Code, Section 13.32, *Wastewater Discharge Limits*.

Additional outside requirements specifying waste acceptance requirements at the Nevada Test Site were contained in:

- U.S. DOE and REEC Co, NVO-325, Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer requirements.

Several SNL/CA site and TRL specific plans and procedures were written and implemented to ensure compliance with all applicable federal, state and local regulations as well as Sandia National Laboratory corporate policies and practices. The following SNL/CA site-wide procedures applied to waste handling operations at the TRL during the TRL Cleanup and Transition project:

- Environmental Protection Department SNL/CA Low-Level Radioactive Waste Quality Assurance Plan
- TRL Inventory Reduction Management Plan and Schedule
- GN470075, Guidelines for Hazardous Waste Generators at SNL/CA
- PG470176, SNL Radiological Control Manual
- OP471587, Operating Procedure for Characterization of Radioactivity in Waste
- SNL/CA Health Protection Department IP28, Control of RMMAs.

The following is a list of TRL-specific procedures implemented for waste handling operations at the TRL during the Cleanup and Transition project:

OP471076	<i>Treatment and Disposal of Acid Containing Low-Level Waste</i>
OP471079	<i>TRL, Compactible Low-Level (Radioactive) Waste Disposal</i>
OP471080	<i>TRL, Non-Compactible Low-Level (Radioactive) Waste Disposal</i>
OP471081	<i>TRL, Low-Level Waste (Radioactive), Water Solidification</i>
OP471083	<i>TRL, Collection, Classification, & Unrestricted Release of Non-Compactible Scrap & Reapplicable Materials</i>
OP471084	<i>TRL, Repackaging of ALM1's for Burial</i>
OP471096	<i>SS Containers, With Small Quantities of Metal Tritides Waste Packaging</i>
OP471101	<i>TRL, Tritiated Water, Solidified on Clay, Waste Packaging</i>
OP471107	<i>Immobilized/Sealed, Tritium Containing, Pyrophoric, Particulate, Waste Packaging</i>
OP471344	<i>TRL, Manifolds and Containers, Waste Packaging</i>

OP471346	<i>TRL, Solid Metal Tritides, Containing Tritium, Waste Packaging</i>
OP471351	<i>TRL, Vacuum Pump Oil, Solidification and Waste Packaging</i>
OP471380	<i>TRL, Cleanup and Removal of Gloveboxes, to VERS and GPS Lines in Bldg. 968</i>
OP471384	<i>TRL, Oversize Container, Waste Packaging Building 968</i>
OP471403	<i>TRL, Low-Level Waste (Radioactive), Liquid Solidification</i>
OP471578	<i>Process Knowledge Evaluation</i>
TRL-012	<i>Overpack Procedure for Vacuum Pump Fluid</i>

Audits and Oversight

Oversight and evaluation of SNL/CA waste handling procedures was provided during four formal audits conducted between May 1993 and April 1996. Conduct of these audits resulted in many procedural and training practice upgrades over the course of the TRL Cleanup and Transition project. The results of these audits are filed by the Environmental Operations Department in the ES&H filing system.

Personnel Training

Throughout the TRL Cleanup and Transition project, all generators of hazardous, radioactive and mixed wastes at SNL/CA were trained in accordance with the guidelines set forth in ES&H Manual Supplement GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*. In compliance with these guidelines, all generators of hazardous, radioactive and/or mixed wastes received the following training sessions, as applied to their individual assignments:

ENV233 - HAZARDOUS WASTE GENERATOR

The objective of this course was to provide SNL/CA chemical waste generators with the necessary information to do their part in maintaining compliance with federal, California, and local regulations and SNL/CA hazardous waste requirements. This course consisted of a 20-minute lecture/viewgraph presentation, and a 5-minute question and answer period. The document, GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*, was summarized. Topics included an overview of SNL/CA hazardous waste operations and services, hazardous waste definition, waste minimization options, container selection, waste acceptance criteria, compatibility of waste streams, labeling, storing, accumulating, and disposal procedures for chemical hazardous wastes.

ENV235 - RADIOACTIVE & MIXED WASTE

The objective of this course was to provide SNL radioactive and mixed waste generators with the necessary information to do their part in maintaining compliance with federal, California, and local regulations, SNL hazardous waste requirements, DOE Orders, and NVO-325. This course consisted of a one-hour lecture/view-graph presentation, an audio-visual viewing of tape NVO-325, a question-and-answer period, and an exam and review. Topics included an overview of SNL/CA radioactive/mixed waste operations and services, waste definitions, waste minimization options, RMMAs, procedure for approval of mixed waste generation, container selection, waste acceptance criteria, compatibility of waste streams, labeling, storing, accumulating, and disposal procedures for radioactive and mixed wastes.

In addition to these courses, many one-time individual training sessions were administered to refresh TRL personnel in correct waste handling practices before major shipments, following procedure revisions and prior to major jobs likely to generate large amounts of waste.

TRL Cleanup and Transition Waste Streams

The following section outlines general waste handling practices for the five major hazardous, radioactive and mixed waste streams generated at the TRL during the Cleanup and Transition project. As listed previously in this document, there are numerous specific and detailed procedures governing step-by-step waste handling operations. This section is not intended to present these step-by-step actions in detail, but rather to describe, in general, the waste handling process at the TRL for each of these waste streams. Specific procedures will be referenced where applicable.

Segregation of Waste Streams

Hazardous, radioactive and mixed wastes generated at the TRL were segregated into five major waste categories:

- Solid, non-compactible, low-level radioactive tritium contaminated waste
- Solid compactible, low-level radioactive tritium contaminated waste
- Low-Level tritium contaminated waste water solidified on clay
- RCRA or California regulated hazardous waste
- Mixed waste (waste containing both a hazardous and a radioactive component)

Each of these types of waste were carefully segregated and processed to minimize final packaged waste volumes, prevent cross contamination of wastes, meet established waste acceptance criteria and prevent unnecessary generation of mixed wastes.

Once we determined an item was waste, the generator of the item determined to which of the above categories the item belonged. If there were some question about the disposition of a waste item, the generator would contact the TRL Health Physics Representative (HPR) who, with the assistance of a Radioactive Waste Representative (RWR), would then determine the disposition of the waste. Based upon the waste category decision, the waste was processed in accordance with the procedures established specifically for that waste stream as outlined in the following sections.

Solid Non-Compactible Low-Level Waste

Solid non-compactible, low-level radioactive waste generated at the TRL during the cleanup and transition project consisted of tritium-contaminated items including:

- experimental hardware, glove boxes, piping
- damaged or surplus tools, instrumentation and equipment
- pressure vessels, open to atmosphere, drained and empty, or quality assurance verified to be less than or equal to atmospheric pressure
- glass bottles, beakers, lids
- crushable cans, paint cans filled with compactible materials, light gage sheet metal containers
- plastic containers, plastic containers filled with compactible materials
- experimental hardware, glove boxes, piping
- damaged or surplus tools, instrumentation and equipment
- neutralized, solidified liquids not containing RCRA or California regulated materials

Once an item was identified as solid, non-compactible waste, it was the responsibility of the generator of the item to certify that the waste met SNL/CA waste acceptance criteria as outlined in GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*. Solid, low-level radioactive waste was not permitted to contain:

- pyrophoric materials
- hazardous waste
- mixed waste
- free liquids
- pressure containing vessels, or potentially pressure containing vessels

In addition, solid waste materials that had been immersed in or otherwise coated with liquids or classified as non-RCRA hazardous materials (oil, water etc.) were required to be drained of liquids for a minimum of 24 hours. After draining for 24

hours, the solid material was classified as low-level waste. The liquids drained from the waste solid were collected and processed as liquid or mixed wastes, as applicable.

It was the responsibility of the waste generator to initiate a *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) and contact the TRL Health Physics Representative (HPR) for assistance in completing the tag and final classification, characterization, and packaging of the waste item. The HPR assisted the generator in determining the amount of radioactivity (curie content) present in the waste item.

Curie content estimations at SNL/CA were accepted by NTS based upon evaluation of the processes performed. Process knowledge evaluations were performed for all radioactive and mixed waste producing processes at the TRL in accordance with OP471578, *Operating Procedure for Process Knowledge Evaluation for Facility-Specific Waste*. The HPR assisted the waste generator in calculating and estimating the curie content of any waste generated. In addition, radiological surveys were performed as a backup verification of calculated curie contents in accordance with OP471587, *Operating Procedure for Characterization of Radioactivity in Waste*.

The estimated curie content was entered onto the *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA). The item was weighed on a calibrated scale, with the results entered onto the *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) in kilograms. The waste was inspected by the HPR, photographed and was packaged in 4'x4'x7' steel boxes (DOT 7A), 55 gallon drums (DOT 17-H), or specially designed DOT and NTS approved oversized steel containers. These containers were kept covered by steel screens to prevent buildup of tritium gas and locked, with the HPR controlling the key, to ensure all items entered into the container were properly characterized, tagged and inspected.

Each DOT-approved waste container was assigned an identifying number by the RWR and inspected by the RWR and HPR prior to use. Each item placed in the container was assigned an identifying number, which was logged on the container's Waste Accumulation Log Sheet, on the item's *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) and on the Polaroid photograph of the item. The *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) included four carbon copies. One copy remained on the waste item, one was retained by the generator and two copies, as well as the original, were retained by the RWR.

As waste was accumulated in a waste container, or when it was full, the contents of the container and associated *Radioactive Waste and Mixed Waste Disposal Tags* (LS 6980-AA) were inspected by the Waste Certification Officer (WCO). The WCO was required to inspect at least 15% of the contents of every waste container shipped to NTS and 100% of all finished containers ready for shipment and document the results of these inspections in the WCO logbook. A 7A steel box or 17-H 55 gallon drum container was considered to be full when either the physical volume of the container was filled, the radioactivity content of the container reached but did not exceed 1000 Curies, or the weight of the container reached but did not exceed its designed weight limit (9000 pounds for a 7A container and 900 pounds for a 17-H 55 gallon drum (or as determined by manufacturer for oversized containers)).

Once a container was full and all required inspections completed, the lid was sealed with a 1/4 inch bead of RTV silicon sealant and mechanically secured with spikes, rings and/or bolts. The secured box was then surveyed by the HPR for tritium outgassing and surface contamination. These surveys were documented on Health Protection form HP-01, *Radiation and Contamination Survey Form*, and a copy placed on the outside of the container. Prior to shipment to NTS, the waste container was surveyed once again to meet transportation requirements in accordance with SNL/CA Health Protection procedures. All formal records of waste tags, log sheets, waste item photographs, WCO Logbooks, and radiological surveys are archived in the SNL/CA ES&H records retention system.

Solid Compactible Low-Level Waste

Solid compactible low-level waste was segregated from solid non-compactible radioactive waste only to facilitate waste volume reduction and was processed in accordance with OP471079, *TRL, Compactible, Low-Level Waste Disposal (Radioactive)*. Once compacted, compactible waste was characterized, classified and processed as solid, non-compactible radioactive waste. Solid compactible, low-level radioactive waste generated at the TRL during the cleanup and transition project consisted of tritium contaminated items including:

- crushable pressure vessels, such as aerosol cans, open to the atmosphere, drained and empty
- glass bottles, beakers, vials, lids, pipettes
- crushable cans, paint cans filled with compactible materials, light gage sheet metal containers
- plastic items, containers, lab equipment and plastic containers filled with compactible materials
- disposable protective clothing, including gloves, lab coats, coveralls and booties
- paper, cardboard, packing materials
- dry paper and cloth rags, mop heads, sponges and clay

Once an item was identified as compactible waste, it was the responsibility of the generator of the item to certify that the waste met SNL/CA waste acceptance criteria as outlined in GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*. Solid, low-level radioactive waste was not permitted to contain:

- pyrophoric material,
- hazardous waste
- mixed waste
- free liquids

- pressure containing vessels, or potentially pressure containing vessels

In addition, solid compactible waste materials that had been immersed in or otherwise coated with liquids, classified as non-RCRA hazardous materials (oil, water etc.), such as mop heads and other cleaning supplies, were required to be drained of liquids for a minimum of 24 hours. After draining for 24 hours, the solid material was classified as low-level waste. The liquids drained from the waste solid were collected and processed as liquid or mixed wastes, as applicable.

Compactible, solid waste was frequently generated on a routine and repetitive basis. These items were placed in clear plastic bags, inside ventilated, clearly marked receptacles located throughout the facility. When a receptacle was full, the HPR would collect the full plastic bag and replace it with a new one. The items in the bag were inspected for compliance with waste acceptance criteria as listed in GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA* and a *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) was initiated for the bag. The bag was taped shut and weighed on a calibrated scale. The HPR estimated the curie content of the item by process knowledge determination, with radiological survey and analysis performed as verification when necessary. The *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) was completed and affixed to the bag. The properly tagged bag of compactible waste was placed in a locked, clearly posted, ventilated 4'x4'x7' steel box (DOT 7A), designated for accumulation of compactible low-level waste.

When the compactible waste 7A container was about 3/4 full of properly tagged plastic bags, the container was transferred to the RWR and transported to Building 961 for compacting operations.

Upon completion of waste compacting operations, the compacted waste was packaged in 17-H 55 gallon steel drums and stored in Building 961 for disposal as solid low-level radioactive waste as described in the previous section. The empty 7A container was returned to Building 968 and returned to service.

Low-Level, Tritium-Contaminated Waste Water Solidified on Clay

Low-level, tritium-contaminated waste water was routinely generated at the TRL during the Cleanup and Transition project in the form of analysis waste, system drainage, decontamination residual and the highly contaminated water (>1.2Ci/l) collected from the Water Recovery System. Most tritium-contaminated waste water generated was collected in the Building 968 drainage system and processed through the waste water collection tanks. Whenever a waste water was generated that contained levels that would contaminate the building drainage system (>10mCi/day as determined by liquid scintillation analysis), the water was collected in approved containers and solidified on clay in accordance with OP471081, *TRL, Low-Level Waste (Radioactive), Water Solidification*.

Contaminated water containing <1.2Ci/l was collected and solidified in DOT 34-15 poly drums containing a free volume of approximately 58 liters and filled with 55 liters of clay. The clay absorbent used in the poly drums was either Florco All-

Purpose Absorbent or Super-Fine Clay Absorbent. The capacity of the poly drum filled with either of these types of clay was 16.5 liters of tritium contaminated water and/or 20 curies of activity, whichever occurred first. The quantity of water activity added to these containers was tracked during loading using an accumulation log sheet attached to the side of the drum. A *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA) was initiated for each drum when placed in service. When the drum was full, the waste tag was completed by the generator of the waste and the HPR and the drum was processed as a solid non-compactible, low-level radioactive waste.

Contaminated water containing $>1.2\text{Ci/l}$ was collected in ASME Code containers. These vessels are described in Sandia drawing A-48488, Supplier drawing No. 3236. The vessel design, construction and workmanship conformed to ASME rules, Section VIII, Division I, 1989 Edition to 1989 Addenda, Lethal Service, ASME Boiler and Pressure Vessel Code, and the vessel was fabricated and certified by an ASME code-certified shop. The Maximum Allowable Working Pressure (MAWP) of the vessel was 100 psi at 150 degrees F. The vessel contained a free volume of 15 liters and was filled with 15 liters of clay. After filling with dry clay, the vessel was weighed on a calibrated Volland Balance to establish the empty weight of the container. This weight was recorded on a tag attached to the container. The capacity of the container was a maximum of 4.5 liters of water (50% of actual capacity) and/or 1000 curies, whichever limit was reached first. Water volume was tracked and measured by weight. Water collected from the Water Recovery System was added to these vessels in accordance with ES&H SOP SP485006, *Water Recovery System*.

Once waste water was properly solidified in one of the above containers, these containers were packaged for burial in accordance with OP471101, *Tritiated Water, Solidified on Clay, Waste Packaging*. This procedure outlines the steps taken in placing each of the above types of containers, as well as waste ALM-1 containers normally used to ship and transfer tritiated water, inside TYPE A, DOT7A, 17H, 55 gallon steel drums. The void space around the container inside the TYPE A, DOT7A, 17H, 55 gallon steel drum was filled with a uniform, measured amount of clay in a prescribed geometry. The package was sealed with RTV silicon sealant, bolted and torqued shut. Once the waste water was properly solidified and packaged, it was processed as low-level, solid non-compactible waste.

Hazardous Wastes

Hazardous wastes presented a significant challenge during the TRL Cleanup and Transition project, as they do at all radiologically controlled sites. Hazardous wastes had to be proven not to contain any DOE-added radioactivity above a statistically based background level, before they could be released from the RMMA. This analysis was performed in accordance with SNL/CA Health Protection procedure HP-10, *Counting Procedures*. If this could not be proven, the waste had to be disposed of as a mixed waste.

Hazardous wastes are wastes containing substances identified or listed in Title 40 CFR 261, or that otherwise meet the Resource Conservation and Recovery Act

(RCRA) definition of hazardous, or waste identified as hazardous by applicable state and local regulations. For the purpose of this document, "hazardous waste" does not include any radioactive component. Examples of hazardous wastes generated at the TRL include: batteries, reagent chemicals, oils and solvents, metals, powders, paints and adhesives.

Once we determined that an item or substance containing hazardous components was no longer useful or needed at the TRL, we considered where it might be useful. If possible, we transferred it to another RMMA, either on site or at another DOE facility, or it was surveyed and released for reuse outside of an RMMA in accordance with SNL/CA Health Protection procedures.

If the item or substance had no use anywhere else, and it was proven free of DOE added radioactivity, it was considered a hazardous waste. An *SNL Hazardous Waste ID Tag* (LS 6980-A) would be initiated for the item and the item would be picked up by the RWR for disposal in accordance with GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*.

Mixed Wastes

A mixed waste is a waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA), respectively. Examples of mixed wastes generated at the TRL during the Cleanup and Transition project included tritium-contaminated, liquid-scintillation cocktail, oils, solvents and metals.

It was often very difficult, as well as costly, to arrange disposal for a mixed. Some mixed wastes could only be placed in a safe, stable condition and stored in a designated location. For this reason, Sandia aggressively avoided the generation of mixed wastes at SNL/CA wherever possible. Mixed waste streams were not generated without written approval from SNL/CA vice president of Center 7000, or vice president of Center 8000 in accordance with MN471001, *ES&H Manual Chapter 19, Section C, Mixed Waste Generator Planning*.

Once an item or substance was determined as mixed waste, a *Radioactive Waste and Mixed Waste Disposal Tag* (LS 6980-AA), as well as an *SNL Hazardous Waste ID Tag* (LS 6980-A) was initiated and the waste was transferred to the RWR for disposal or storage, as applicable.

One notable innovation was realized involving the mixed waste liquid scintillation cocktail generated by the HPR in the process of radiological analysis. Liquid scintillation cocktail was a liquid containing a solvent and a fluor that was mixed with a sample (water, cotton swab, oil etc.) and analyzed using the liquid scintillation counter. The solvent most commonly used prior to 1993 was a RCRA listed (toluene) liquid. Thus, mixing this liquid with radioactive samples created a mixed waste that was eventually transferred to a vendor for off site disposal. In 1993, this cocktail was replaced with one of the new non-RCRA listed, environmentally safe cocktails, that had the added advantage of allowing a larger sample load in a smaller volume of cocktail. This facilitated the reduction of

sample vial size from 20 ml vials to 7 ml vials. Thus, half the volume of cocktail waste was generated and the waste was no longer technically "mixed."

Housekeeping Practices

Tritium contamination at the TRL was limited to the space inside of glove boxes, High Velocity Air Hoods (HVAHs), closed vessels and system plumbing. Whenever tritium contamination was spread outside of these locations, either by spill, system leakage or movement of contaminated equipment, it was cleaned up as soon as possible to less than 1000 dpm/100cm². Floors were mopped on a routine schedule to prevent slow buildup of surface contamination. Laboratories were maintained in an organized and uncluttered manner. Tritium contaminated areas and equipment were clearly posted to prevent inadvertent spread of contamination. Unnecessary items, such as excess equipment and bulk supplies were stored outside of the facility until needed to minimize clutter.

Radiological surveys, including direct wipe, surface scanning and air monitoring, were performed on a frequent and routine basis to ensure early detection of any contamination spread. The EG&G/Berthold LB1210 with the LB 6255 tritium surface scanning probe was used to locate small spots, or drops where contaminated material might have been leaked or spilled, that would otherwise be easily missed by surface wiping techniques alone.

These practices contributed greatly to minimizing the total volume of waste generated during the TRL Cleanup and Transition project. The radiological cleanliness of the facility allowed the uncontrolled release of an estimated 95% of facility tools, equipment and materials, eventually including the building itself (Building 968). It is estimated that a savings of nearly 25 million dollars in waste disposal costs were realized by avoiding demolition and disposal of an entire contaminated facility.

Reapplication and Recycling Practices

During the Cleanup and Transition project, an item was considered to be waste when it had no further economically realizable value. Since most everything has "some" value, the primary consideration became whether the item could be proven to be releasable (<1000 dpm/100cm²) by radiological survey and analysis. This involved time and expense in and of itself. Therefore, if the item was not worth the time it would take to survey it, it was disposed as low-level radioactive waste. This type of waste constituted the bulk of waste, especially the compactible waste, disposed of at the TRL. When an item possessed economic value above the cost of the survey, reapplication or recycling was considered.

An estimated 43 million dollars worth of equipment was reapplied either on site or at other DOE facilities. Uncontaminated items were surveyed and released for uncontrolled use. Contaminated items were either decontaminated and released, or transferred to other radiologically controlled facilities. Examples of reapplied

equipment include, glove boxes, HVAHs, tools, instrumentation, computer equipment, and chemical supplies.

Few items were recycled during the Cleanup and Transition project. Occasionally, metal items were released from the facility and recycled as scrap metal with the precondition that it was likely that the metal had never been contaminated, that it could be easily surveyed, and that it was surveyed and proven releasable in accordance with SNL/CA Health Protection procedures. Common recyclable materials, such as paper, glass, and plastic, used inside the boundaries of the RMMA were not recycled at the TRL.

Removal of Decontamination Systems

The decontamination systems (Gas Purification System, Vacuum Effluent Recovery System, Ventilation System, and Waste Water Evaporator System) at the former TRL were extensively contaminated and required careful planning for their safe assessment, decontamination, disassembly, packaging and disposal. Each system had unique characteristics which presented the staff with a multitude of challenges. These challenges included issues such as: how to assess the level of contamination within the system?, how to cleanup or reduce the level of contamination prior to disassembly of the system?, how to minimize personnel exposure during the entire process?, how to minimize the environmental releases during the process?, how to safely disassemble the system and store components prior to packaging?, how to package the system and its components within Nevada Test Site's waste acceptance criteria?

Gas Purification System

The Gas Purification System consisted of three main operational skids tied to a building wide manifold which serviced all labs in the TRL. The initial radiological assessment of the system's internal contamination levels were performed using the in-line tritium process monitors. Due to the great quantities of tritium processed through the system over the years, the process monitors were used as an indicator to determine the effectiveness of initial decontamination efforts. The decontamination of the system was accomplished while cleaning up the glove boxes and "to GPS lines". The "to GPS lines" were the sections of the system that tied the main manifold to the glove boxes. The cleanup of these sections and glove boxes was done with an exchange process where room air and/or water vapor was introduced into the areas, allowed to exchange and cleaned up using the GPS. This process also allowed for the decontamination of the main hallway manifold and its system components and minimized environmental releases by capturing the bulk of the exchanged tritium in the system. Following the initial cleanup of the main system using the effects of the glove box cleanups, the system was opened at each room penetration. This allowed the main hallway manifold to be exposed to room air directly. With the manifold open, a radiological assessment was performed by Health Physics to quantify the activity of the systems' manifold and hazards associated with disassembly. A snorkel ventilation exhaust duct was connected to

the open lines to prevent the possibility of exposure to personnel working in the area. As the cleanup of the system occurred, the water that was collected in the GPS dryers was processed as waste using the Water Recovery Glove Box (SP485006) and waste packaging procedure OP471101.

Due to the size of the systems' components and their location throughout the TRL building, special handling and storage was required. The safe handling, packaging and disposal was done through the Safe Work Permit process (#471034) where all hazards associated with this operation were addressed. Disassembly of these components for processing as waste in standard conforming waste containers would require undue risk from both the radioactive materials handling and safety aspect. An agreement was reached with NTS to allow for the use of Oversized Waste Containers (SP471384) for the processing of these systems as well as other large items such as glove boxes. In order to optimize the space within these waste containers and to provide for safe storage prior to loading, wooden boxes were fabricated at sizes to fit into the oversize container. This served to fill all the available space by packaging waste to fit in a jig-saw type arrangement which surrounded the largest item/s to be packaged. This process reduced the number of cuts of hallway and roof manifolds by ~60%, and it also reduced personnel exposures and environmental releases.

Vacuum Effluent Recovery System

The Vacuum Effluent Recovery System served as a collection system for tritium contaminated gases generated in experiments at the TRL. Gases from experimental operations and vacuum-pump exhausts, which were tritium contaminated, were processed through this system. The systems' main components were housed in lab 115A and its manifold ran through the main corridor and ultimately was pumped into one of two 5.7 cubic meter holding tanks located on the building 968 roof. Due to the great quantities of tritium processed through the system over the years, the process monitors were used as an indicator to determine the effectiveness of initial decontamination efforts. Following the initial cleanup efforts, the Portable Tritium Monitoring System (PTMS) was used to make more defined estimates on the tritium concentration within the VERS. The operation of the PTMS, which was designed and built at the TRL was done per SOP #SP472672. The decontamination of the system was accomplished using an air exchange process which was ultimately processed through the GPS for tritiated water collection and then released to the environment.

Due to the size of the systems' components and their location throughout the TRL building including multiple penetrations through the roof to the hold tanks, special handling and storage was required. Disassembly of these components for safe handling, packaging and disposal was done through the Safe Work Permit process (#471031) where all hazards associated with this operation were addressed. Because of the systems' assembly almost 100% copper brazed, the ability to remotely drain residual oil from the interior of isolated sections was impossible. The system was disassembled using the "jaws of life" by cutting vertical sections first utilizing a

snorkel ventilation and then draining the horizontal sections manually to collect residual oil trapped in the lines. Following the collection and processing of the oil, the remainder of the manifold system was cut into sections inside a portable exhaust ventilation roll-around High Velocity Air Hood (HVAH) and sealed in DOT Type 7A 55-gallon drums. All sections of the VERS were sealed in the 55-gallon drums to provide for their safe storage prior to final waste packaging and to minimize personnel exposures and environmental releases.

Ventilation System

The building ventilation system ducting was analyzed using liquid scintillation counting techniques and all sections in excess of regulatory limits were removed using manual techniques. The levels of contamination posed no health hazard risks to personnel or the environment. All sections were removed and then sealed with plastic for storage prior to final waste packaging in oversized waste containers.

Waste Water Evaporator

The Waste Water Evaporator System was analyzed using liquid scintillation counting techniques and all sections in excess of regulatory limits were removed using manual techniques. The levels of contamination were low and posed no health hazard risks to personnel or the environment. Final waste packaging was done in standard conforming waste containers.

Environmental Releases During Cleanup and Transition Activities 1993-1996

1993 - During the year approximately 110 curies of the 188 curie total can be attributed to initial clean-up operations and the maintenance and repairs of the VERS. Additional activities contributing to the releases were water recovery and packaging operations, and inventory reduction.

1994 - - During the year approximately 50 curies of the 95 curie total can be attributed to VERS and GPS decontamination efforts, glove box separation operations and placing all glove boxes in stack mode. The reduction in environmental releases from 1993 is primarily due to the waste packaging of off-gassing equipment and material from the lab.

1995 - During the year approximately 58 curies of the 74 curie total can be attributed to VERS and GPS decontamination efforts.

1996 - During the year only small residual release occurred approximately 0.078 curies. The largest portion of the minimal release was attributed to ventilation ducting removal operations.

REFERENCES

1. U.S. Environmental Protection Agency (EPA), Title 40CFR, Parts 260-268, Resource Conservation and Recovery Act (RCRA);
2. U.S. EPA, Title 40 CFR, Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs) and
3. U.S. Congress, Clean Air Act Amendment of 1990, specifically the National Ambient Air Quality Standards (NAAQS);
4. State of California, Title 22, California Code of Regulations (CCR), Division 4.5, *Environmental Health Standards for the Management of Hazardous Waste*.
5. The City of Livermore Municipal Code, Section 13.32, *Wastewater Discharge Limits*.
6. U.S. DOE and REEC Co, NVO-325, *Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer requirements*.
7. Environmental Protection Department SNL/CA *Low-Level Radioactive Waste Quality Assurance Plan*
8. SAND96-8004, *Radiological Characterization and Final Facility Status Report Tritium Research Laboratory*
9. *TRL Inventory Reduction Management Plan and Schedule*
10. GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*
11. PG470176 *SNL Radiological Control Manual*
12. OP471578 *Operating Procedure for Process Knowledge Evaluation for Facility-Specific Waste*
13. OP471587 *Operating Procedure for Characterization of Radioactivity in Waste*
14. OP471076 *Treatment and Disposal of Acid Containing Low-Level Waste*
15. OP471079 *TRL, Compactible Low-Level (Radioactive) Waste Disposal*
16. OP471080 *TRL, Non-Compactible Low-Level (Radioactive) Waste Disposal*
17. OP471081 *TRL, Low-Level Waste (Radioactive), Water Solidification*
18. OP471083 *TRL, Collection, Classification, & Unrestricted Release of Non-Compactible Scrap & Reapplicable Materials*
19. OP471084 *TRL, Repackaging of ALM1's for Burial*
20. OP471096 *SS Containers, With Small Quantities of Metal Tritides Waste Packaging*
21. OP471101 *TRL, Tritiated Water, Solidified on Clay, Waste Packaging*

22. OP471107 *Immobilized/Sealed, Tritium Containing, Pyrophoric, Particulate, Waste Packaging*
23. OP471344 *TRL, Manifolds and Containers, Waste Packaging*
24. OP471346 *TRL, Solid Metal Tritides, Containing Tritium, Waste Packaging*
25. OP471351 *TRL, Vacuum Pump Oil, Solidification and Waste Packaging*
26. OP471380 *TRL, Cleanup and Removal of Gloveboxes, to VERS & GPS Lines in Bldg. 968*
27. OP471384 *TRL, Oversize Container, Waste Packaging Building 968*
28. OP471403, *TRL, Low-Level Waste (Radioactive), Liquid Solidification*
29. SP472830 *TRL Facility Operating Procedure*
30. TRL-012, *Overpack Procedure for Vacuum Pump Fluid*

GLOSSARY

certified waste	Waste that has been confirmed to comply with disposal site waste acceptance criteria under an approved certification program.
free liquids	Liquids that readily separate from the solid portion of a waste under ambient temperature and pressure.
hazardous wastes	Waste identified or listed in Title 40 CFR 261, or that otherwise meets the Resource Conservation and Recovery Act (RCRA) definition of hazardous, or waste identified by applicable state and local regulations. For the purpose of this document, "hazardous waste" does not include any radioactive component.
low-level waste	Waste in which there is any measurable increase in radioactivity, at a statistically defined confidence interval, above background. This may be measured by process knowledge, radiological survey, or sampling and analysis (radioassay); or by a combination of these techniques.
mixed waste	Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA), respectively.
pyrophoric material	A material that, under normal conditions, is liable to cause fires through friction, retained heat from manufacturing or processing, or that can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard.
Radioactive Material Management Area	or RMMA, an area in which a reasonable potential exists for contamination due to the presence of unencapsulated or unconfined radioactive material or an area that is exposed to beams or particles capable of causing activation.
radioactive waste	Waste materials, materials with no recoverable value, in solid, liquid or gaseous form that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended and of negligible economic value considering costs of recovery.
solid waste	Material that is an essentially dry, solid form. Waste may include well drained containers, or liquids that have been entrapped or otherwise solidified so that they

will retain their solid form without the presence of free liquids during handling, transportation, storage or disposal. Viscous waste material is determined to be solid by testing in accordance with American Society of Testing Materials Standard D-4359, *Standard Test Method for Determining Whether a Material is a Liquid or a Solid*.

- treatment** Any method, technique, or process designed to change the physical or chemical character of waste to render it less hazardous, safe to transport, store or dispose of, or reduced in volume.
- waste container** A receptacle for waste, including any liner or shielding material that is intended to accompany the waste in disposal.
- waste package** The waste, waste container, and any absorbent that are intended for disposal as a unit. In the case of surface contaminated, damaged, leaking, or breach waste packages, any overpack shall be considered the waste container, and the original container shall be considered part of the waste.

Attachment 1
Waste Packaging and Waste Disposal Report

Sandia National Laboratories
Livermore, California 94551-0969

date: July 31, 1996

to: Don Putz, 8346 MS9671

from:
Sarah C. K. O'Connor (8418) and Val Pestañas (8346)

subject: Waste Packaging and Waste Disposal Report

Attached is a report on the Waste Disposal and Waste Packaging Processes used during the Clean Up and Transition Period at the Tritium Research Laboratory (TRL).

This report meets the finish date (July 31, 1996) of task ID No. 41 as stated in the TRL Transition Plan, dated 7/12/96.

Concurrence with task closure:

D. W. Putz, Manager, Dept. 8346

7/31/96
Date

Copy to:
MS 9671 TRL Transition Project Plan File
MS 9671 8346 Personnel
MS 9671 T. B. Garcia, 8421
MS 9671 T. P. Gorman, 8421
MS 9221 J. J. Bartel, 8418
MS 9221 S. C. K. O'Connor, 8418
MS 9671 V. V. Pestañas, 8346

TRITIUM RESEARCH LABORATORY LOW-LEVEL RADIOACTIVE WASTE PACKAGING & WASTE DISPOSAL REPORT

Sarah C.K. O'Connor, (8418) and Val Pestañas, (8346)

BACKGROUND:

The Tritium Research Laboratory (TRL) at Sandia National Laboratories/California (SNL/CA) began service in 1977. Its mission was to provide an applied research capability for the study of tritium and its effect on weapon materials. After many years of successful tritium research activities, it became apparent that the cost of nuclear facility operation was increasing rapidly. The costs associated with operations, ES&H requirements, and full compliance with formal operating procedures, made it difficult to operate a nuclear facility at Livermore or carry out the TRL mission in a cost effective way.

In 1991, Sandia concluded that tritium research at other DOE facilities could support its mission. Sandia notified DOE of the intention to cease tritium operations at the TRL. Following the initial announcement, several discussions occurred among the TRL staff, experimenters, and ES&H waste program personnel to work out details in disposing the accountable tritium, laboratory equipment and the contaminated waste that would be generated by this work. TRL invited organizations within Sandia, as well as national laboratories involved with tritium work, to visit the TRL facility and give them the opportunity to acquire equipment, experiments, and accountable tritium in various forms and container configurations.

During the entire clean-up period, Sandia's Health Physics personnel monitored and evaluated the contamination levels in equipment and containers, as well as any item that was taken out of the TRL complex.

All contaminated left-over containers, equipment, experiments and hardware were disposed of as low-level radioactive waste. The waste disposal period described in this report covers waste shipments to NTS from June 1993 to April 1996. The packaging and disposal processes were performed according to procedures established by Sandia ES&H Waste Program personnel and the Nevada Test Site (NTS) Waste Acceptance Criteria (WAC). The flow chart in Figure 1 illustrates the detailed disposal process for wastes, both compactible and non-compactible, generated at the TRL.

Figure 2 is a graphical summary of all the TRL low-level radioactive waste shipments made to NTS during the clean up and transition period. Figure 2 contains two graphs which illustrate (1) TRL-LLW Curie Content, and (2) TRL-LLW Shipment Volumes.

All shipments were accomplished through a collaborative effort among the TRL staff, ES&H Waste Program personnel, ES&H Health Physics personnel, and the Nuclear Material Management Group which included the Nuclear Material Representative and the Traffic Analyst.

WASTE DESCRIPTION

The waste shipments in June and July 1993 consisted mainly of tritiated water solidified in clay. The tritiated water came from the regeneration process of the Vacuum Effluent Recovery System (VERS) and the Gas Purification System (GPS) dryers in Bldg. 968.

The tritiated water solidified in clay were collected in vessels known as ALM-1. These vessels were packaged individually inside a Department of Transportation (DOT)-approved Type A, 55-gallon drum containers and shipped to NTS. Any Type A shipment indicates that the curie content for each individual container is less than 1000 curies. As shown in the second graph in Figure 2, the volume of TRL-generated wastes shipped in June 1993 was 27% of the total volume shipped to NTS, and 74% of the total shipped in July 1993.

As shown in the first graph in Figure 2, the April 1994 waste shipment contained the largest curie content of all shipments. The items included in this shipment consisted of several tritiated water absorbed on clay and a number of metal tritide samples for long term studies. The tritiated water vessels were individually packaged inside DOT-approved 55-gallon drums. The metal tritide samples were also packaged in DOT 55-gallon drums. Several samples were placed in each drum as long as the total curie content did not exceed 1000 for each drum to qualify for the Type A shipment requirement.

The first graph in Figure 2 shows a significant drop in curie content between the October 1994 shipment and the 1995 shipments. This is due to the fact that all containers with accountable amounts of tritium (i.e. greater than 50 curies for each container) were all disposed of at the October 1994 shipment. The TRL staff set a goal to dispose all accountable amounts of tritium by January 1995. This goal was met three months ahead of schedule.

All low-level waste shipments made in 1995 and 1996 were primarily TRL-generated, as shown on the second graph in Figure 2. The shipments were all part of the low-level contaminated waste shipment with no accountable amount of tritium. The first August 1995 shipment consisted mainly of hardware such as piping, holding tanks, gloveboxes, lab trash, parts of a decontamination system, and other miscellaneous hardware which although contaminated had very low curie content. However, the volume of the TRL shipment was bigger than previous shipments because of the size of the manifolds and the remaining hardware. Oversized DOT-approved 7A shipping containers were used to package the items and shipped to NTS.

The September 1995 shipment and the final shipment in April 1996 consisted mostly of compactible wastes such as lab coats, gloves and miscellaneous waste items, and several pieces of ductwork that were removed from building 968. All contaminated items left at the TRL complex were packaged for this final shipment. One oversized DOT-approved 7A container was used. This shipment closed out the waste stream that is covered under the Low-Level Radioactive Waste Management Plan for Sandia National Laboratories/California.

DOCUMENTATION

Included in this report as Appendices are documents that supported the waste packaging and waste disposal processes. These are:

- Appendix 1 - List of TRL Operating Procedures (OPs) related to Low-Level Radioactive Waste Disposal and Packaging
- Appendix 2 - Process Knowledge Evaluation No. 001-968, in accordance with OP471578
- Appendix 3 - Excerpts (TRL-related wastes only) from Low-Level Radioactive Waste Management Plan for SNL/CA, 1993 to Oct. 1994.
- Appendix 4 - Excerpts (TRL-related wastes only) from Low-Level Radioactive Waste Management Plan for SNL/CA, June 1995.

Figure 1

TRL EFFLUENT FLOW CHART

WAC Waste Acceptance Criteria
 DOT Department of Transportation
 WCO Waste Certification Official
 RWR Radioactive Waste Representative
 HPR Health Physics Representative
 HWT Hazardous Waste Technician
 WPE Waste Program Engineer
 WIS Waste Information System
 CFR Code of Federal Regulations

Figure 2

TRL Waste Shipment History

APPENDIX 1

List of TRL Operating Procedures (OPs) related to Low-Level Radioactive Waste Disposal and Waste Packaging

[These documents are located at the TRL Central Filing Area,
in a white binder marked Operating Procedures (OPs)]

- OP 471079 TRL, Compactible Low-Level Waste Disposal
(Radioactive)**
- OP 471080 TRL, Non-Compactible Low-Level Waste Disposal
(Radioactive)**
- OP 471081 TRL, Low-Level Waste (Radioactive), Water
Solidification, Bldg. 968**
- OP 471084 TRL, Re-packaging of ALM-1 Containers for Burial**
- OP 471096 TRL, Stainless Steel Containers, with Small Quantities
of Metal Tritides, Waste Packaging**
- OP 471101 TRL, Tritiated Water, Solidified on Clay, Waste
Packaging, Bldg. 968**
- OP 471344 TRL, Manifolds and Vessel, Waste Packaging**
- OP 471346 TRL, Solid Metal Tritides Containing Tritium,
Waste Packaging, Bldg. 968**
- OP 471384 TRL, Oversize Container, Waste Packaging, Bldg.968**
- OP 471403 TRL, Low-Level Waste (Radioactive) Liquid
Solidification, Bldg. 968**

APPENDIX 2

**Process Knowledge Evaluation No. 001-968
in accordance with OP 471578**

PROCESS KNOWLEDGE EVALUATION

PKE No.: 001968
WPE Here: 10/20

SECTION I: PROCESS INFORMATION (To be completed by Lead Experimenter/Room Responsible Person/Project Supervisor)

1. Building 968 2. Room Facility 3. Workstation/Glove box/Hood: _____

4.	Describe Activity Generating Waste and Estimated Completion Date: <u>The activities and systems associated with the operation of Bldg. 968 (formerly the tritium Research Laboratory) have supported the transition of the facility from a non-reactor nuclear facility to a user facility with a radiological hazard. The effort includes the removal and reallocation of excess equipment from Bldg. 968. The Bldg.968 Clean-Up and Transition is the activity of waste generation. Estimated completion date, January 1998.</u>		
5.	Briefly describe the process(es) in this area: <u>The facility space consists of laboratory and office areas. The facility is undergoing removal of equipment no longer in use. The equipment includes glove-boxes, test equipment, a Mass Spectrometer, Calorimeter, and vacuum and plumbing assemblies. During the disassembly and removal of contaminated equipment, the facility's systems will be operated as necessary to support the activity. The high pressure and assay stations were used to transfer/deliver tritium gas from one vessel to another for experimenter's use and for gas analysis.</u>		
6	Are Process procedures/instructions utilized?	(X) Yes	O No
6.1	If yes, please list. <u>SP 472822 TRL High Pressure Station, Building 968</u> <u>SP 472825 TRL Assay Station, Building 968</u> <u>SP 472818 TRL Nitrogen Backfilled Sealed Gloveboxes.</u> <u>Building 968 SOP</u>		
7.	Are any regulated RCRA or California-listed hazardous materials a part of this work station or used in or created by these processes?	(X) Yes	O No
8.	If yes, please list and explain how they are used. <u>Toxic Chemical/Material Handling /Storage & Highly flammable material stored or processed: Chemicals used in the facility are primarily limited to adhesives, cleaning solvents, and lubricants. Some of the chemicals used and/or stored in this facility are also considered flammable liquids by NFPA standards. The attached Chemical Inventory provides a list of types and quantities of chemicals and flammable liquids that are used and stored by Department 8281. All chemicals are handled and stored in strict accordance with the documents listed below (question 9.0). Chemicals are tracked through the Chemical Information System (CIS) controlled by the Environmental Operations Department (8644).</u>		

9.0	Is (Are) there (a) procedure(s) to control the use and disposal (X) Yes O No
	<p>of regulated hazardous materials and to prevent them from commingling with radioactive material?</p> <ul style="list-style-type: none"> • GN470075 SNL Guidelines for Hazardous Waste Generators • SAND88-3332 Guide to Chemical Hazard Communications • SAND91-8005B Guidelines for Radioactive and Mixed Waste Generators • Various Safe Work Permits
9.1	If yes, Please list and explain how the are used:
	<p><u>In the facility there is limited collection of chemicals: Bldg. 968 and ES&H Safe Operating Procedures (SOPs), Safe Work Permits(SWPs) and Operating Procedures (OPs) exist which define the procedures for handling and disposing of waste.</u></p> <p><u>SWP94-63 High Pressure Station (HPS) Glovebox 1</u></p> <p><u>SWP94-62 Assay Station Glovebox 5A</u></p> <p><u>SP472818 TRL Nitrogen Backfilled Sealed Gloveboxes, Building 968</u></p> <p><u>SP472822 TRL High Pressure Station, Building 968</u></p> <p><u>SP472825 TRL Assay Station, Building 968</u></p> <p><u>OP471344 TRL Manifolds and Vessels, Waste Packaging Building 968</u></p> <p><u>OP471384 TRL TRL Oversize Container, Waste Packaging, Building 968</u></p> <p><u>OP451080 TRL, Non-Compactible, Low-Level Waste Disposal (Radioactive)</u></p> <p><u>OP471403 TRL, Low-Level Waste (Radioactive) Liquid Solidification</u></p> <p><u>OP471433, Administrative Procedure for Waste Certification</u></p> <p><u>ES&H Manual Supplement - ES&H Manual Supplement - Guidelines for Hazardous Waste Generators at SNL/CA (GN-470075)</u></p>
9.2	If No, how are regulated hazardous materials controlled to prevent them from commingling with or contaminating radioactive waste? <u>Not applicable.</u>
	<hr/> <hr/> <hr/>
10.	Will this process generate mix waste (radioactive and (X) Yes O No hazardous)?
	<p><u>There is a potential for mixed LLW generation however, currently not foreseen with clean-up and transition activities on-going at Bldg. 968. The continuous effort at Bldg. 968 is to keep chemical usage to an absolute minimum and look for non-hazardous substitutes for hazardous materials. LLW will be verified to meet all SNL/CA WAC.</u></p>

Process Knowledge Evaluation Form Continuation

11. Will the radioactive waste contain any of the following:											
ASBESTOS	☐	Yes	☒	No	FINE PARTICLES	☐	Yes	☒	No		
CHELATING AGENTS	☐	Yes	☒	No	FREE LIQUIDS	☐	Yes	☒	No		
CLASSIFIED	☐	Yes	☒	No	PCBs	☐	Yes	☒	No		
COMPRESSED GASES	☐	Yes	☒	No	PYROPHORICS	☐	Yes	☒	No		
ETIOLOGICAL	☐	Yes	☒	No	TRANSURANICS	☐	Yes	☒	No		
EXPLOSIVE	☐	Yes	☒	No	FISSILE ISOTOPES	☐	Yes	☒	No		

12. Will the radioactive waste exhibit the following characteristics?											
CORROSIVE	☐	Yes	☒	No	IGNITABLE	☐	Yes	☒	No		
TOXIC	☐	Yes	☒	No	REACTIVE	☐	Yes	☒	No		
DECAY HEAT	☐	Yes	☒	No							

NOTE: If any items in 11 or 12 above are marked YES, complete the applicable Waste Stream Evaluation forms.

13. Will any resulting waste contain listed hazardous materials? if yes, list constituents. ☐ Yes ☒ No		
14. List all radionuclides present in the waste stream. <u>Tritium.</u>		
15. Mark all regulated waste type products produced:	☒ LLW ☒ LLW California Hazard ☒ LLW & RCRA Mixed	☒ Hazardous ☐ Biohazard
16. List all components of waste generated by the process or any other activities in this area. Indicate any that may contain hazardous materials.		
<u>Miscellaneous</u> Floor-Dry Absorbent Glass Protective Clothing: Cotton, Plastic Pylox, Tyvec, Saranex Rubber Gaskets Tygon Tubing Lucite Nylon Seals Polystyrene Polyethylene (HDPE)	<u>Scrap Metals:</u> 304 & 316 Stainless Steel 4043 & 5356 Aluminum Copper Gaskets, Nickel Plated Copper Tubing Copper Wire Brass Valves Mild Steel	<u>Hazardous Materials</u> CIS Listing - See attached Chemical Information System, hazardous material log.
17. Comments: <u>Prior to sealing of the waste container, each waste item is listed on Department 8642 Waste Accumulation Sheet. the Radioactive Waste Representatives perform their inspections according to OP471344, and the Waste Certification Official inspects 15% of the packaged waste and 100% of the finished package.</u>		
18. Val Pestanas (8281) <u>V. Pestanas</u> Lead Experimenter/Room Responsible Person/Project Supervisor		4-13-95 Date 3/15/95

NOTE: When processes are significantly changed, this form must be re-evaluated and revised as necessary.

Process Knowledge Evaluation Form
Continuation

Section II: ENVIRONMENTAL REVIEW (To be completed by Waste Program Engineer)

19. Visually examine chemical stocks in the area. Are any of the following categories of materials present?							
ASBESTOS	☐	Yes	☒	No	FINE PARTICLES	☐	Yes ☒ No
CHELATING AGENTS	☐	Yes	☒	No	FREE LIQUIDS	☐	Yes ☒ No
CLASSIFIED	☐	Yes	☒	No	PCBs	☐	Yes ☒ No
COMPRESSED GASES	☐	Yes	☒	No	PYROPHORICS	☐	Yes ☒ No
ETHIOLOGICAL	☐	Yes	☒	No	TRANSURANICS	☐	Yes ☒ No
EXPLOSIVE	☐	Yes	☒	No	FISSILE ISOTOPES	☐	Yes ☒ No
CORROSIVE	☐	Yes	☒	No	IGNITABLE	☐	Yes ☒ No
TOXIC	☐	Yes	☒	No	REACTIVE	☐	Yes ☒ No
DECAY HEAT	☐	Yes	☒	No			
NOTE: if any of the above blocks are marked yes, evaluate controls described on applicable Waste Stream Evaluation form.							
20. Process procedure evaluation completed? ☒ Yes ☐ No							
If yes, list procedures:							
<u>SWP94-63 High Pressure Station (HPS) Glovebox 1</u>							
<u>SWP94-62 Assay Station Glovebox 5A</u>							
<u>SP472818 TRL Nitrogen Backfilled Sealed Gloveboxes. Building 968</u>							
<u>SP472822 TRL High Pressure Station. Building 968</u>							
<u>SP472825 TRL Assay Station. Building 968</u>							
<u>OP471344 TRL Manifolds and Vessels. Waste Packaging Building 968</u>							
<u>OP471384 TRL TRL Oversize Container. Waste Packaging. Building 968</u>							
<u>OP451080 TRL Non-Compactible, Low-Level Waste Disposal (Radioactive)</u>							
<u>OP471403 TRL Low-Level Waste (Radioactive) Liquid Solidification</u>							
<u>OP471433. Administrative Procedure for Waste Certification</u>							
<u>ES&H Manual Supplement - ES&H Manual Supplement - Guidelines for Hazardous Waste Generators at SNL/CA (GN-470075)</u>							
21. Additional available information to support Process Knowledge							
<u>Preliminary Hazardous Assessment. Building 968. PA94312-1</u>							
<u>MSDS</u>							
<u>Chemical Information System</u>							
<u>Radiation Surveys</u>							
<u>Oil Sampling Analysis of TRL Vacuum Pump Oil</u>							
<i>(Will be formalized and submitted)</i>							
22. The following regulated waste types are produced:							
☒ LLW	☒ Hazardous						
☒ LLW RCRA Mixed	☐ Biohazardous						
☒ LLW + CA Hazardous							

23. Comments: _____
24. <u> </u> Waste Program Engineer
Date <u>4/12/95</u>

Section III REVIEW SIGNATURES

I have reviewed Sections I and II and found them to be complete and accurate. I have also reviewed the controls on hazardous materials and found them acceptable.

25. <u> </u> Waste Certification Official
Date <u>4/10/95</u>

LLW WASTE STREAM EVALUATION

1. PKE No. 001-968			
2. Building <u>968</u>	3. Room <u>Facility</u>	4. Workstation/Glovebox/Hood <u>N/A</u>	

This disposal form documents the Authorized Components List and specific controls for the management and disposal of LLW in accordance with the SNL/CA LLW Certification Program.

5. Waste Stream Identification Number - <u>ASLL-0004RWTWS</u>
6. Substream Number(s) (if applicable) <u>N/A</u>
<p>7. Describe actions taken to either prevent contamination of the LLW waste stream or to comply with the DOE/NV Waste Acceptance Criteria</p> <p><u>Any personnel handling radioactive material must be trained on the requirements for SNL/CA Radioactive and Mixed Waste Acceptance Criteria and NVO-325 Awareness. All trained personnel are considered "Qualified LLW Generators" and will be given a controlled procedure "SNL/CA Guidelines for Hazardous Waste Generators." for waste acceptance, segregation, minimization and handling practices in current compliance with NVO-325 waste acceptance criteria. Training will take place annually</u></p>
<p>8. Guidance for additional controls for segregation of waste:</p> <p><u>LLW will only be dispose of through Environmental Protection following SNL Guidelines for Hazardous Waste generators, and the facility's operating procedures that have been review by WPE and WCO. The Chemical Information System Inventory is also reviewed.</u></p>
<p>Concurrence:</p> <p>_____</p> <p>_____</p>
9. Authorized Components List:

<ul style="list-style-type: none"> • tile, paint(dried, non-lead), ceiling materials • plastic-ware, bags bottles, foam, rubber, hose • paper, kimwipes, paper towels • glassware-empty • PPE - gloves, shoe covers, lab coats • solidified decon solutions • gas manifolds - pressure relieved • gas cylinders- valves remove • Absorbent material, clay • 	<ul style="list-style-type: none"> • heaters, ovens - asbestos free • wiring, gages, panels • pipe, manifolds • glove boxes, hoods • containers(≤5gal) • filters, fans, vents • drywall, roofing materials • lights, cable trays • Pumps-drained (24hrs) • machining equipment
--	--

X
10. Val Portanova 4/12/95
Lead Experimenter/Room, Responsible Person/Project Supervisor Date
11. Dan C. O'Connor 4/12/95
Waste Program Engineer Date

12. Waste Stream was reviewed for compliance with:

(X) NVO-325, Rev. 1
O Other

and found to be in accordance with the SNL/CA LLW Waste Certification Program.

Don E. Galt 4/13/95
13. Waste Certification Official Date

WASTE CHARACTERIZATION SUMMARY FORM

Date 2/14

1. Waste Characterization

Check One:

- ☒ Process Knowledge Waste Stream
☐ Sampling and Analysis Waste Stream
☐ Both Process Knowledge and Sampling and Analysis
☐ Process Knowledge Supported by Confirmatory Sampling

2. Waste Stream # ASLL-0004RWTWS Sub-Waste #s 001-968

3. Date Waste Generation began: 1/78

4. Date Waste Generation ended: 1/98

5. Average Annual Waste Generation Rate 80 m³

6. Physical state of waste ☒ Solid ☐ Liquid ☐ Gas

7. Waste treatment performed? ☐ Yes ☒ No

8. Description of Waste Characterization

This waste stream was characterized in accordance with OP471578 Process Knowledge Evaluation. These forms are updated whenever the process changes and are reviewed on an annual basis. From the process knowledge evaluation, authorized components lists were generated for the waste stream the Qualified LLW generator is provided with this components list. The RWR verifies the waste meets the authorized components list.

Waste Description:

The activities and systems associated with the operation of Bldg. 968, (formerly the Tritium Research Laboratory), have supported the transition of the facility from a non-reactor nuclear facility to a user facility with a radiological hazard. This effort includes the removal of excess equipment from Bldg. 968 for waste disposal. The facility space consists of laboratory and office areas including: the Component Development Lab, Assembly/Disassembly Lab, a monitoring room, a tritium gas purification equipment room, an Analysis & Assay Lab, a Health Physics Laboratory, and a waste staging area. The facility is undergoing removal of equipment no longer in use. The equipment includes glove-boxes, test equipment, and vacuum and plumbing assemblies. During the disassembly and removal of contaminated equipment, the facility's systems will be operated as necessary to support the activity, that will also be disposed. The Vacuum Effluent Recovery System (VERS) and the Gas Purification System (GPS) are the building decontamination systems. VERS is one of the building decontamination systems. The purpose of the VERS is to collect, store, and decontaminate tritium contaminated effluent from systems located throughout Bldg. 968. The GPS removes tritium gas, and tritiated hydrocarbons from the sealed glovebox gases. The GPS system consists of a control system, a main manifold, carbon traps, a blower section, a catalyst section, a dryer section, and a regeneration section. Waste stream consists predominately of tritium contaminated items from dismantlement activities in Bldg. 968. Waste items include cleanup system hardware, piping, glassware, glove boxes, manifolds and containers. Waste water solidified on clay such as and water with ethylene glycol. Compactible waste (PPE, wipes, paper and plastic, etc.) will be used to fill void space in waste package. The final form of this waste stream is a solid meeting the site WAC. No RCRA or California-regulated constituents are present in this waste stream.

9. Support Documentation:

Check all that apply:

(x) Process Knowledge Evaluation (PKE) forms- list numbers and process.

PKE# 001-968 Clean and Transition of Bldg.968

O Analytical Data- list sample analysis and briefly describe sampling.

Not Applicable

O Sampling and Analysis Plans- list report numbers and titles.

Not Applicable

(x) Procedures- list numbers and titles.

OP471354 Health Physics Work Place Survey

OP471080, *TRL, Solid, Non-Compactible, Low-Level Waste (Radioactive) Disposal*

OP471403, *TRL, Low-Level Waste (Radioactive) Liquid Solidification*

OP471384, *TRL, Oversize Container, Waste Packaging*

OP471344, *TRL, Manifolds and Containers, Waste Packaging*

OP471587, *Characterization of Radioactivity in Waste*

OP471380, *TRL Cleanup and Removal of Gloveboxes, to VERS and GPS Lines in Bldg. 968*

HP-10, *Health Physic Counting Procedure*

Radiation Instrument Program Requirements for Radiation Protection Instrumentation

Engineering Procedure, Calibration Program.

IP 5.03, Control of Measuring and Test Equipment

SP472690, *Low-Level Radioactive Waste and Mixed Waste, Building 961 (U).*

SP485007, *Low-Level Radioactive Waste Storage, Building 968, Room 129 (U).*

SP472823, *Tritium Research Laboratory, Vacuum Effluent Recovery System*

SP472818, *Tritium Research Laboratory, Nitrogen Backfilled Sealed Gloveboxes*

SP472824, *Tritium Research Laboratory, Gas Purification System*

SP472825, *Tritium Research Laboratory, Assay Station*

OP471102, *Waste Container Receipt Inspection*

OP471103, *Facility/Equipment Inspection Verification*

OP WM09, *Radioactive Waste Information System Database*

OP WM13, *Compaction of Radioactive Waste with the NUPAC model WC18000 Compactor*

OP471088, *Compaction of Low-Level Radioactive Waste with the Compaction Control Ind., Model BB-100-E Compactor*

OP WM22, *Drum Storage*

OP471125, *Non-Conforming or Condemned Item Identification, Form Logging and Tracking*

OP471095, *Packaging and Storage of Radioactive Waste in the Radioactive & Mixed Waste Storage Facility/Building*

OP471095, *Radioactive Waste Pickup and Transportation*

OP471578, *Process Knowledge Evaluation for Facility-Specific Waste Streams*

(x) Waste Disposal Tags- describe availability:

Waste Disposal Tags are available in the Environmental Protection - Waste Package Files per container and the Hazardous Files.

(x) Maps/Drawings- describe

SNL/CA site maps showing location of the buildings are available.

O Interviews- describe

Not Applicable

(x) Others- Specify: (Memo to File)

W. R. Wall, "Tritium Research Laboratory, Ethylene Glycol, Process Knowledge, Documentation," January, 21, 1994

10. Comments:

11. Completed by Waste Program Engineer:

Print Name SARAH C. K. O'CONNOR Signature *Sarah C. K. O'Connor* Date 4/13/95

12. Reviewed and Approved by Waste Certification Official:

Print Name DAWN WRIGHT Signature *Dawn Wright* Date 4/13/95

APPENDIX 3

**Excerpts (TRL-related wastes only) from
Low-Level Radioactive Waste Management Plan for SNL/CA,
1993 to Oct. 1994**

3.0 WASTE STREAM INFORMATION (ASLL-0004RWTWS)

3.1 WASTE STREAM IDENTIFICATION NUMBER

ASLL-0004RWTWS

3.2 WASTE TYPE

Low-Level Waste

3.3 WASTE DESCRIPTION

Waste Stream ASLL-0004RWTWS consists predominately of tritium, but may also contain uranium or thorium, contaminated noncompactible items including experimental hardware, piping, glassware, glove boxes, small amounts of neutralized, contaminated acids not containing RCRA or California-regulated metals and small amounts of tritium contaminated paper and plastic used for cushioning materials and to ensure the box is completely full and surplus components and subassemblies. Some contaminated equipment may be damaged or non-recyclable surplus. The tritium or uranium contaminated neutralized acids are generated mainly in cleaning and polishing operations for sample preparation. The final form of this waste stream is a solid meeting the site waste acceptance criteria. The majority of this waste stream is generated at the Tritium Research Laboratory from experiments, monitoring and daily maintenance operations. However, some of the items are generated in other research and development laboratories.

This waste stream will be stored and shipped in certified 4'x4'x7' steel boxes and 55 gallon drums. Some of the containers in this waste stream are classified.

3.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: A S L L - 0 0 0 4 R W T W S
2. Waste Description:
 - a. Physical Characteristic: Consists of tritium contaminated noncompactible items including experimental hardware, glove boxes, small amounts of neutralized, contaminated acids not containing RCRA or California regulated metals, water solidified in clay and small amounts of paper and plastic. This waste stream also contains uranium and thorium contaminated non-compactibles from research activities.
 - b. Special Handling/Disposal Requirements: This waste stream may contain classified materials.
3. Basis for Characterization:
 - a. Process Knowledge: X
 - b. Analytical Knowledge:

c. Both: _____

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:

a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No

b. WMIS Nuclide Category (underline): 1 2 3 4 5 NA 7

(Choose the highest predominate nuclide. The number 6 is not an option.)

c. Radioactive Constituents:

Waste Stream		Specific Activity Range of			
<u>Nuclide</u>	<u>Chemical Forms</u>	<u>Low</u>	<u>Mean</u>	<u>High</u>	<u>(Units)</u>
(1) ^{238}U	Uranium oxide	0	0.1	3.6	$\times 10^{-4}\text{Ci/l}$
(2) ^3H	HTO, DTO	0	10	100	Ci/kg
(3) ^{232}Th	Thorium oxide	0	0.1	1.0	$\times 10^{-4}\text{Ci/k}$
(4)					

5. Hazardous Components (for MW): This waste stream contains no hazardous components. This section is not applicable to this waste stream.

3.8 PACKAGING AND SHIPPING INFORMATION

All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping names used for this waste stream are:

- 1) Radioactive Material, n.o.s., 7, UN 2982
- 2) Radioactive Material, Low Specific Activity, n.o.s., 7, UN2912

The containers used to package this waste stream are 55 gallon drums and 4 ft. x 4 ft. x 7 ft steel boxes.

3.9 WASTE SECURITY INFORMATION

Some of the containers in this waste stream are classified.

4.0 WASTE STREAM INFORMATION (ASLL-0008RWSTW)

4.1 WASTE STREAM IDENTIFICATION NUMBER

ASLL-0008RWSTW

4.2 WASTE TYPE

Low-Level Waste

4.3 WASTE DESCRIPTION

Waste Stream ASLL-0008RWSTW consists of solidified tritiated water. Water is generated by the TRL tritium gas cleanup system. Tritiated water is handled according to the SOP, *Water Recovery System*. Regenerated water from the Tritium Research Laboratory tritium gas cleanup system is never contaminated with any substance which could make the water a mixed waste. The water is passed through a closed system. This waste is solidified into kegs by the TRL health physics representatives and then overpacked into certified 55 gallon drums, see TRL OP-4, *Water Solidification Process*. Clay is added to the drum as cushioning material to protect the certified outer shipping container. The radioactive waste representative verifies that the waste is properly packaged before accepting the waste. The original form of this waste stream is a liquid. After treatment (solidification) is completed, the final waste form is a solid.

This waste stream is mainly stored and shipped in certified 55 gallon drums. There may be occasion to use 4' x 4' x 7' 7A steel boxes for packaging and shipping. This waste stream is unclassified.

4.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: A S L L - 0 0 0 8 R W S T W

2. Waste Description:

- a. Physical Characteristics: Consists of solidified tritiated water.
- b. Special Handling/Disposal Requirements: None

3. Basis for Characterization:

- a. Process Knowledge: X
- b. Analytical Knowledge:
- c. Both:

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:

- a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No

b. WMIS Nuclide Category (underline): 1 2 3 4 5 NA 7

(Choose the highest predominate nuclide. The number 6 is not an option.)

c. Radioactive Constituents:

Waste Stream		Specific Activity Range of			
<u>Nuclide</u>	<u>Chemical Forms</u>	<u>Low</u>	<u>Mean</u>	<u>High</u>	<u>(Units)</u>
(1) ^3H	HTO, DTO	1	10	1000	Ci/kg
(2)					
(3)					
(4)					

5. Hazardous Components (for MW): This waste stream contains no hazardous components. This section is not applicable to this waste stream.

4.8 PACKAGING AND SHIPPING INFORMATION

All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping name used is:

1) Radioactive Material, n.o.s., 7, UN 2982

The containers used to package this waste stream are 55 gallon drums and 4 ft. x 4 ft. x 7 ft steel boxes.

4.9 WASTE SECURITY INFORMATION

This waste stream is unclassified.

WASTE STREAM INFORMATION (ASLL-0009RWTCW)

5.1 WASTE STREAM IDENTIFICATION NUMBER

ASLL-0009RWTCW

5.2 WASTE TYPE

Low-Level Waste

5.3 WASTE DESCRIPTION

Waste Stream ASLL-0009RWTCW consists predominately of tritium, but may also contain uranium, contaminated compactible waste, paper, plastic, rubber, and glass. About 99 percent of this waste stream is generated at the TRL. The rest is generated in research and development laboratories. The majority of this waste stream is personal protective equipment (gloves, lab coats, booties) and the remainder is paper/plastic/glass waste. This waste stream is a solid waste stream that is treated by compaction to reduce the volume. The final form of this waste stream is a solid meeting the site waste acceptance criteria. This waste stream will be shipped in certified 55 gallon drums. This waste stream is unclassified.

5.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: ASLL - 0009RWTCW
2. Waste Description:
 - a. Physical Characteristics: Consists of tritium and uranium contaminated paper, plastic, rubber, and glass that has been compacted.
 - b. Special Handling/Disposal Requirements: None
3. Basis for Characterization:
 - a. Process Knowledge: X
 - b. Analytical Knowledge:
 - c. Both:

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:
 - a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No
 - b. WMIS Nuclide Category (underline): 1 2 3 4 5 NA 7
(Choose the highest predominate nuclide. The number 6 is not an option.)

c. Radioactive Constituents:

		Specific Activity Range of Waste Stream			
	<u>Nuclide</u>	<u>Chemical Forms</u> <u>High</u>	<u>Low</u> <u>(Units)</u>	<u>Mean</u>	
(1)	^3H	HTO, DTO	0	1	20 Ci/kg
(2)	^{238}U	Uranium oxides	0	0.01	1 x 10 ⁻⁴ C
(3)					
(4)					

5. Hazardous Components (for MW): This waste stream contains no hazardous components. This section is not applicable to this waste stream.

5.8 PACKAGING AND SHIPPING INFORMATION

All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping name used is:

- 1) Radioactive Material, Low Specific Activity, n.o.s., 7, UN2912
- 2) Radioactive Material, n.o.s., 7, UN2982

The containers used to package this waste stream is 55 gallon drums. On occasion 4' x4' x7' 7A boxes may be used to package and store this waste stream.

5.9 WASTE SECURITY INFORMATION

This waste stream is unclassified.

WASTE STREAM INFORMATION (ASLL-0011RWNPO)

6.1 WASTE STREAM IDENTIFICATION NUMBER

ASLL-0011RWNPO

6.2 WASTE TYPE

Low-Level Waste

6.3 WASTE DESCRIPTION

Waste Stream ASLL-0011RWNPO consists of uranium oxides, tritium, polonium and uranium contaminated noncompactible items including experimental hardware, glove boxes, neutralized/solidified acids not containing RCRA or California regulated metals, paper and plastic used as filler or cushioning material, and damaged or surplus components and subassemblies. The polonium is a very small waste stream that is rarely generated, but still requires disposal. Tritium or uranium contaminated materials are used to fill up the certified 4'x4'x7' steel box for disposal. Therefore, the tritium contaminated material is an integral part of this waste stream. The original and final form of this waste stream will be a solid meeting the SNL/CA waste acceptance criteria.

This waste stream is classified and is packaged in 4' x 4' x 7' steel boxes and 55 gallon drums.

6.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: ASLL - 0011RWNPO

2. Waste Description:

a. Physical Characteristics: Consists of tritium, polonium, uranium oxides and uranium contaminated noncompactible items including experimental hardware, glove boxes, small amounts of neutralized, contaminated acids not containing RCRA or California regulated metals, small amounts of paper and plastic and damaged or surplus components and subassemblies.

b. Special Handling/Disposal Requirements: This is a classified waste stream.

3. Basis for Characterization:

a. Process Knowledge: X

b. Analytical Knowledge:

c. Both:

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:

a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No

b. WMIS Nuclide Category (underline): 1 2 3 4 5 NA 7

(Choose the highest predominate nuclide. The number 6 is not an option.)

c. Radioactive Constituents:

Waste Stream		Specific Activity Range of			
	Nuclide	Chemical Forms	Low	Mean	High (Units)
(1)	^3H	HTO, DTO	0	0.1	10 Ci/kg
(2)	^{238}U	Uranium oxide	0	0.01	1 x 10^{-4} Ci/l
(3)	^{210}Po	Polonium metal*	0	1.0	10 x 10^{-4} Ci/l
(4)					

5. Hazardous Components (for MW): This waste stream contains no hazardous components. This section is not applicable to this waste stream.

* The polonium metal is electroplated or bonded onto a substrate.

6.8 PACKAGING AND SHIPPING INFORMATION

All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping names used are:

- 1) Radioactive Material, n.o.s., 7, UN 2982
- 2) Radioactive Material, Low Specific Activity, 7, n.o.s. UN2912

The containers used to package this waste stream are 55 gallon drums and 4 ft. x 4 ft. x 7 ft steel boxes.

6.9 WASTE SECURITY INFORMATION

This is a classified waste stream and shall be handled in such a manner to ensure that security requirements are met.

7.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: A S L L - 0 0 1 2 R W T U S

2. Waste Description:

- a. Physical Characteristics: Tritium and uranium contaminated noncompactible items including experimental hardware, gloveboxes, small amounts of neutralized and solidified acids that do not contain RCRA or California metals, tritiated waste absorbed in clay, small amounts of paper and plastic used for filler and damages or surplus components and subassemblies.
- b. Special Handling/Disposal Requirements: This is a classified waste stream.

3. Basis for Characterization:

- a. Process Knowledge: X
- b. Analytical Knowledge:
- c. Both:

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:

a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No

b. WMIS Nuclide Category (underline): 1 2 3 4 5 NA 7

(Choose the highest predominate nuclide. The number 6 is not an option.)

c. Radioactive Constituents:

Waste Stream		Specific Activity Range of			
<u>Nuclide</u>	<u>Chemical Forms</u>	<u>Low</u>	<u>Mean</u>	<u>High</u>	<u>(U)</u>
(1) ^{238}U	Uranium oxide	0	0.01	1.0	$\times 10^{-4}$
(2) ^3H	HTO, DTO	0	0.1	10	C

5. Hazardous Components (for MW): This waste stream contains no hazardous components. This section is not applicable to this waste stream.

7.8 PACKAGING AND SHIPPING INFORMATION

All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping names used are:

- 1). Radioactive Material, Low Specific Activity, n.o.s., 7, UN 2912
- 2). Radioactive Material, n.o.s., 7, UN 2982

The containers used to package this waste stream are 4 ft. x 4 ft. x 7 ft steel boxes.

7.9 WASTE SECURITY INFORMATION

This is a classified waste stream and shall be handled in such a manner to ensure that security requirements are met.

APPENDIX 4

Excerpts (TRL-related wastes only) from
Low-Level Radioactive Waste Management Plan for SNL/CA,
June 1995

3.0 WASTE STREAM INFORMATION

LLW generated by SNL/CA, proposed to be shipped to the NTS, is indicated as follows:

1. Solid Tritiated Waste from Bldg. 968

ASLL-0004RWTWS

3.1 WASTE STREAM IDENTIFICATION NUMBER

ASLL-0004RWTWS

3.2 WASTE TYPE

Low-Level Waste.

3.3 WASTE DESCRIPTION

This waste stream consists of LLW associated with operations located in Bldg.968. This waste stream consists of tritium contaminated items such as experimental hardware, piping, glassware, gloveboxes, manifolds, and containers, personal protective equipment, lab trash and waste solidified on clay such as ethylene glycol and water.

The ethylene glycol wastes are generated from building monitoring processes at Bldg.968. All manifolds and containers will be verified to contain less than 1.5 atmospheres of pressure and will be capped to assure no unnecessary tritium exposure. The final form of this waste stream is a solid with no free liquids.

3.4 WASTE CERTIFICATION FLOW DIAGRAM

Figure 3 is a waste certification flow diagram that describes the certification process for this waste stream.

3.5 WASTE ACCEPTANCE CRITERIA STATEMENTS

3.5.1 LOW-LEVEL WASTE ACCEPTANCE CRITERIA

ASLL-0004RWTWS

3.5.1.1 General Waste Form Criteria

- A. Transuranics: *LLW must have a transuranic nuclide concentration less than 100nCi/g. The mass of the waste container including shielding shall not be used in calculating the specific activity of the waste in accordance with NVO-325 (Rev.1) Section 5.5.1.1.A.*

Compliance Method: Not applicable. There are no transuranics with the exception of sealed sources, which have been segregated and will not be commingled with this waste stream, in Bldg. 968. The determination of the nuclide is in accordance with OP471587, *Characterization of Radioactivity in Waste* performed by SNL/CA Health Physics Department.

- B. Hazardous Waste Components: *LLW offered for disposal at NTS waste management sites shall not exhibit any characteristics of, or be listed as hazardous waste as identified in Title 40 CFR 261, "Identification and Listing of Hazardous Waste" or State of California Hazardous Waste Control Law.. (NVO-325(Rev.1) Section 5.5.1.1.B)*

Compliance Method: This waste stream does not contain listed hazardous waste and does not exhibit hazardous waste characteristics. The Building 968 Process Knowledge Evaluation (Bldg.968 PKE, OP471433), SOP's, OP's, and SWPs document administrative and physical controls of material utilized in the facility to achieve compliance with this requirement. The site-wide Chemical Inventory System (CIS) is also reviewed for this facility. Personnel responsible for identifying, characterizing, and certifying LLW shall receive training on hazardous characteristics and listed hazardous wastes. Verification is performed by SNL/CA personnel according to the requirements of the *LLW QA Plan*.

- C. Free Liquids: *Free liquids means liquids readily separate from the solid portion of a waste under ambient temperature and pressure conditions. (NVO-325[Rev.1]Section 5.5.1.1.C)*

Compliance Method: This requirement is evaluated by process knowledge, waste segregation, visual verification, and evaluation. Free liquids will not be present in this waste stream. This waste stream consists of solid waste. Any drained equipment has been back filled with an absorbent material. If absorbent material was added to a waste for control of free liquids, the volume of the liquid was calculated and twice as much of sorbent material, sufficient to absorb the liquid, was used. Refer to OP471403, *TRL Low-Level Waste (Radioactive) Liquid Solidification*.

- D. Particulates: *Fine particulate wastes shall be immobilized so that the waste package contains no more than one weight percent of less than ten micrometer diameter particles, or 15 weight percent of less-than-200-micrometer-diameter particles. Waste that is known to be in a particulate form or in a form that could mechanically or chemically be transformed to a particulate during handling and interim storage shall be immobilized. (NVO-325[Rev.1] Section 5.5.1.1.D)*

Compliance Method: LLW is evaluated by process knowledge or segregated and evaluated for particulates in accordance to controlled procedure. Fine particulate wastes shall be immobilized so that the waste package contains no more than one weight percent of less-than-ten-micrometer-diameter particles, or 15 weight percent of less-than-200-micrometer-diameter particles, with radioactive contamination. Refer to Bldg. 968 PKE, OP471578.

- E. Gases: *LLW gases will be stabilized or absorbed so that pressure in the waste packaged does not exceed 1.5 atmospheres at 20°C. Compressed gases as defined by Title 49 CFR 173.300, including unpunctured aerosol cans, will not be accepted for disposal. Aerosol cans will have puncture disfigurements recognizable by Real-Time Radiography (RTR). Expended gas cylinders must have the valve mechanism removed. (NVO-325[Rev.1] Section 5.5.1.1.E)*

Compliance Method: To achieve compliance with this criterion, SNL/CA will utilize strict controls on emptying gas cylinders and manifolds and preparing them for disposal. Each manifold and container will be certified as meeting this criterion. Because of ALARA considerations, SNL/CA will not remove the valve assemblies from the manifolds or containers. SNL/CA is applying for an exemption to allow for this practice. See section 5.0. Compressed gas as defined by Title 49 CFR 173.300, including unpunctured aerosol cans, will not be disposed of in LLW containers. Compressed gases and intact aerosol cans will be segregated. Non-hazardous aerosol cans will be punctured and placed in LLW containers in accordance with the LLW handling and packaging procedures. Waste verified according to OP471344, TRL, *Manifolds and Containers, Waste Packaging*.

- F. Stabilization: *Where practical, waste shall be treated to reduce volume, promote waste minimization and provide a more structurally and chemically stable waste form. (NVO-325[Rev.1] Section 5.5.1.1.F)*

Compliance Method: LLW from Bldg. 968 consists of contaminated equipment and debris with radionuclides and is an inherently stable waste form. Procedures governing stabilization and control measures are performed in accordance with NVO-325(Rev.1) as defined in Bldg. 968 PKE, OP471578 and OP471384, *Oversized Container, Waste Packaging*.

- G. Etiologic Agents: *LLW containing pathogens, infectious wastes, or other etiologic agents as defined in Title 49 CFR 173.386 will not be accepted for disposal at NTS. (NVO-325[Rev.1] Section 5.5.1.1.G)*

Compliance Method: Not applicable - There are no etiologic agents in this waste stream. Control measures are defined in the Bldg. 968 PKE, following OP471578.

- H. Chelating Agents: *LLW containing chelating or complexing agents at concentrations greater than one percent by weight of the waste form will not be accepted. (NVO-325[Rev.1] Section 5.5.1.1.H)*

Compliance Method: As determined by process knowledge and administrative controls, chelating and complexing agents are not present in Bldg. 968 waste. Control measures are defined in the Bldg. 968 PKE, following OP471578

- I. Polychlorinated Biphenyls (PCBs): *PCB contaminated LLW will not be accepted for disposal at NTS unless the PCB concentration meets municipal solid waste disposal levels of 50 ppm or less. See Title 40 CFR 761.60 for PCB requirements. (NVO-325[Rev.1] Section 5.5.1.1.I)*

Compliance Method: Inventory controls shall be used to assure that PCBs are not present in this waste stream. Control measures are defined in Bldg. 968 PKE, OP471578.

- J. Explosives and Pyrophorics: *LLW containing explosive and or pyrophoric material in a form that may spontaneously explode or combust if the container is breached, will not be accepted. (NVO-325[Rev.1] Section 5.5.1.1.J)*

Compliance Method: Explosives are not present in the Bldg. 968 waste stream. This waste stream does not exhibit pyrophoric properties. Control measures are defined in the Bldg. 968 PKE, OP471578.

3.5.1.2 General Regulatory Waste Package Criteria

- A. Design: *Type A packaging shall be designed to meet Title 49 CFR 173.411, "Federal Design Requirements." and Title 49 CFR 173.412, Additional Design Requirements for Type A Packages, are used for storage and disposal. Type A packages must have been evaluated under the DOE Type A Certification Program(see MLM-3245, DOT 7A Type A Certification Document or succeeding DOE publication). Type B packages meet the applicable requirements of Title 10 CFR 71. Strong, tight packaging used for shipping limited quantities and low specific activity excepted by Titles 49 CFR 173.421 and 173.425, respectively, must be constructed so that it will not leak during normal*

transportation and handling conditions. (NVO-325 [Rev.1] Section 5.5.1.2.A)

Compliance Method: SNL/CA containers are designed to comply with 49 CFR 173.411, *General Design Requirements*, 49 CFR 173.412, *Additional Design for Requirements for Type A Packages*, and 49 CFR 173.474, *Quality Control for Construction of Packaging*. Strong, tight packaging will be used in shipping limited quantities and low specific activity LLW by Title 49CFR173.421 and 173.425, respectively, packaging must be constructed so that it will not leak during normal transportation and handling conditions.

- B. Nuclear Safety: *The quantity of fissile radioactive materials shall be limited so that an infinite array of such packages will remain subcritical. This quantity shall be determined on the basis of a specific nuclear safety analysis, considering credible accident situations, and taking into account the actual materials in the waste. See Title 49 CFR 173.451, Fissile Materials - General Requirements. (NVO-325 [Rev.1] Section 5.5.1.2.B)*

Compliance Method: Not applicable. This waste meets the requirements of Title 49 CFR 173.451, *Fissile Materials - General Requirements*. Control measures are defined in Bldg. 968 PKE, OP471578.

- C. Nuclear Heating: *The quantity of radioactive materials shall be limited for each waste matrix and package type so that the effects of nuclear decay heat will not adversely affect the physical or chemical stability of the contents or package integrity. See Title 49 CFR 173.442, Thermal Limitations, for temperature limits of accessible external package surfaces. (NVO-325 [Rev.1] Section 5.5.1.2.C)*

Compliance Method: The heat of decay from tritium is minimal; therefore, the effects of nuclear decay heat will not adversely affect the physical or chemical stability of the contents or the integrity of the package and will not exceed the thermal limitations of 49 CFR 173.442. Radiation levels are determined following OP471587, *Characterization of Radioactivity in Waste*, control measures are defined in Bldg. 968 PKE, OP471578 and.

- D. Radiation Levels: *The external radiation levels for packages shall not exceed 200 millirems per hour on contact during handling, shipment, and disposal unless specifically excepted by DOT regulations. See Title 49 CFR 173.441, Radiation Level Limitations. Type B containers that will be unloaded by remote procedures will be addressed on a case-by-case basis. (NVO-325 [Rev.1] Section 5.5.1.2.D)*

Compliance Method: Packages will be surveyed externally for radiation levels in accordance with 49 CFR 173.441. The external radiation levels for packages shall not exceed 200 millirem per hour on contact during handling, shipment, and disposal unless specifically excepted by DOT regulations. Radiation levels are determined

following OP471587, *Characterization of Radioactivity in Waste* and control measures are defined in Bldg. 968 PKE, OP471578.

- E. External Contamination: Packages shall be within DOT external contamination limits upon receipt at NTS. See Title 49 CFR 173.443, *Contamination Control* and DOE Order 5480.11, *Radiation Protection for Occupational Workers*. (NVO-325 [Rev.1] Section 5.5.1.2.E)

Compliance Method: Packages will be surveyed for nonfixed (removable) radioactive contamination on each waste container surface to ensure levels are in accordance with 49 CFR 173.443(a). Radiation levels are determined following OP471587, *Characterization of Radioactivity in Waste* and control measures are defined in Bldg. 968 PKE, following OP471578.

- F. Activity Limits: The activity limits listed in Title 49 CFR 173.431, *Activity Limits for Type A and Type B Packages*, shall be met. Where applicable, the activity limits of Title 49 CFR 173.421, *Limited Quantities of Radioactive Materials*, and 49 CFR 173.425, *Transport Requirements for Low-Specific Activity Radioactive Materials*, shall be met for strong, tight packages. See NVO-325 [Rev.1] Section 5.5.2 for additional requirements for activity limits outside of this range. (NVO-325 [Rev.1] Section 5.5.1.2.F)

Compliance Method: Activity levels associated with waste stream will fall into two shipping categories:

Low Specific Activity, as defined in Title 49 CFR

Type A packaging quantities, as defined in Title 49 CFR.

Radioactivity is determined following OP471587, *Characterization of Radioactivity in Waste* and control measures are defined in Bldg. 968 PKE, following OP471578.

- G. Multiple Hazards: Waste containing multiple hazards shall be packaged according to the level of hazards as defined in Title 49 CFR 173.2, *Classification of Material Having More than One Hazard*. (NVO-325 [Rev.1] Section 5.5.1.2.G)

Compliance Method: Materials associated with this waste stream are evaluated by process knowledge and there are no multiple hazards. Control measures and process knowledge documentation are defined in Bldg. 968 PKE, following OP471578.

All of SNL/California's LLW streams are defined as a single hazard class (radioactive material). Therefore, requirements of 49 CFR 173.2 for packaging material having more than one hazard are not applicable.

3.5.1.3 NTS Specific Package Criteria

- A. Closure: *The package closure shall be sturdy enough that it will not be breached under normal handling conditions and will not serve as a weak point for package failure (NVO-325 [Rev.1] Section 5.5.1.3.A)*

Compliance Method: Each waste package is securely closed and sealed to prevent leakage during normal handling. Closure will not serve as a weak point for package failure. The lids, for the metal boxes, are equipped with a rubber gasket on the sealing surface, and are secured to the box with metal locking clips. The lids, for the UN/DOT (55 gallon) drums, are also equipped with a rubber gasket on the sealing surface. The drum lids are secured to the drum with a locking ring, bolt and nut. The bolt is tightened to 40 foot pounds with a calibrated torque wrench. Refer to OP471095, *Packaging and Storage of Radioactive Waste*.

- B. Strength: *Except for bulk waste, waste packaged in steel drums, or SEALAND containers, the waste package (packaging and contents) shall be capable of supporting a uniformly distributed load of (19,528kg/m²) 4,000 lbs/ft². This is required to support other waste packages and earth cover without crushing during stacking and covering operations. (NVO-325 [Rev.1] Section 5.5.1.3.B)*

Compliance Method: Waste packages are designed and purchased to meet NTS criteria. Except for steel drums, bulk waste and transportainers, waste containers shall be capable of supporting a uniformly distributed load of (19,528kg/m²) 4,000 lbs/ft². Refer to OP471102, *Waste Container Receipt Inspections*.

- C. Handling: *All waste packages shall be provided with permanently attached skids, cleats, offsets, handles, or other auxiliary lifting devices to allow handling by means of forklifts, cranes, or similar handling equipment. Lifting rings and other auxiliary lifting devices on the package are permissible, provided they are recessed, offset, or hinged in a manner that does not inhibit stacking the packages. The lifting devices must be designed to a 5:1 safety factor based on the ultimate strength of the material. All rigging devices that are not permanently attached to the waste package must have a current load test passed on 125 percent of the safe working load. (NVO-325 [Rev.1] Section 5.5.1.3.C)*

Compliance Method: Waste packages shall be provided with permanently attached skids, cleats, offsets, rings, handles, or other auxiliary lifting devices to allow handling by means of a forklift, crane, or similar handling equipment.

- D. Size: 1.2 x 1.2 x 2.1m (4 ft. x 4 ft. x 7 ft.) or 1.2x0.6x2.1m (4x2x7 ft.) (width x height x length) boxes or 208-liter (55-gallon) drums are to be used. Bulk waste container approval is discussed in NVO-325(Rev.1) Section 5.5.4. While these sizes allow optimum stacking efficiency in disposal cells, other dimensions are acceptable with approval from DOE/NV on a case-by-case basis. (NVO-325 [Rev.1] Section 5.5.1.3.D)

Compliance Method: Outer waste packages used for shipment of LLW to NTS shall allow for optimum stacking efficiency in the disposal cells. Size of containers used for disposal to NTS will be 55 gallon (208-liter) UN/DOT drums, 4 ft. x 4 ft. x 7 ft. boxes (external dimensions), an occasional 4'x 4'x 7' box overpacks (exact outside dimensions - 50"x 50" x 86") and a few oversized DOT approved boxes (in denominations of 4'x4'x7') are used for waste storage and shipments. A few waste items in this waste stream due to weight, size, and shape will be shipped as bulk waste. DOE/NV WMD will be informed off all oversized waste items prior to shipment. SNL/CA will request packaging and shipping guidance prior to shipment of all oversized waste packages. Other container dimensions will be approved by DOE/NV on a case-by-case basis, prior to waste packaging.

- E. Weight: In addition to the weight limits set for specific packaging designs, NTS imposes limits of 4,082kg (9000 pounds) per box and 544kg (1,200 pounds) per 208-liter (55-gallon) drum. Packages exceeding 4,082kg (9,000 pounds) require crane or large forklift removal and must be approved by the REEC Co Waste Management Department (WMD) prior to shipment. Shipments of this type must be in a removable-top or removable -side trailer. (NVO-325 [Rev.1] Section 5.5.1.3.E)

Compliance Method: Waste packages are weighed to assure gross weight does not exceed permissible weight limits: 55-gallon drums permissible certified design payload not to exceed 1,200 lb. (544kg); boxes, 9000 pounds (4,082kg). Approval for containers exceeding the weight limits stated above will be secured from, and prior notification of shipment will be given to, REEC Co/WMD so that special handling arrangements can be made. Refer to OP471095, *Packaging and Storage of Radioactive Waste* and OP471102 *Waste Container Receipt Inspection*.

- F. Loading: Waste package shall be loaded to ensure that the interior volume is as efficiently and compactly loaded as practical. High-density loading will allow efficient RWMS space utilization and provide a more stable waste form that will reduce subsidence and enhance the long-term performance of the disposal site. (NVO-325 [Rev.1] Section 5.5.1.3.F)

Compliance Method: Each waste package is loaded to ensure that the interior volume is as efficiently and compactly loaded as practical. A wood framing apparatus will be fabricated to stabilize equipment in the oversized container to ensure that the waste item will be secure during transport and disposal. Refer to OP471095, *Packaging and Storage of Radioactive Waste* and OP471102 *Waste Container Receipt Inspection*.

- G. Nonstandard Type A Packaging: Use of DOT Type A packages not previously evaluated under the DOE Type A package Certification Program (see MLM-3245, etc.) will not be permitted. (NVO-325 [Rev.1] Section 5.5.1.3.G)

Compliance Method: Nonstandard Type A Packaging will not be used for LLW disposal. Packaging shall meet NTS criteria. Refer to OP471095, *Packaging and Storage of Radioactive Waste in The Radioactive & Mixed Waste Storage Facility/Building 961*.

- H. Package Protection: The generator shall take the following precautions to protect the waste package after closure.

1. The preshipment storage environment shall be controlled to avoid adverse influence from weather or other factors on the containment capability of the waste packaging during handling, storage, and transport. The generator preparing waste for preshipment storage shall take all reasonable precautions to preclude the accumulation of moisture on or in packages prior to their arrival at NTS.
2. A form of Tamper Indicating Device (TID) shall be applied to each waste container, once certification has been completed.
3. Each waste package is prepared for shipment so as to minimize damage during transit. Minor damage incurred during transit, not attributable to poor packaging, will be repaired at the RWMS without charge to the waste generator. Costs for repairs of damage caused by waste generator or carrier negligence as well as any necessary decontamination to meet DOE Order 5480.11 will be charged to the waste generator. (NVO-325 [Rev.1] Section 5.5.1.3.H)

Compliance Method: SNL/CA shall prepare waste shipments to minimize damage during shipment and storage in accordance to the *LLW QA Plan* and packaging, transport and storage operating procedures. Refer to OP471095, *Packaging and Storage of Radioactive Waste* and OP471102 *Waste Container Receipt Inspection*.

I. Marking and Labeling: *Each waste package shall have the following information affixed:*

- 1. Marking and labeling as required in Title 49 CFR 172, subparts D and E.*
- 2. Signed NV-211 "Packaging Certification" label (revision date January 27, 1989). See figure 8, page 76 of the NVO-325(Rev.1). If the waste is unpackaged bulk, a signed NV-211 label must accompany the shipment papers. These labels can be obtained from DOE/NV-WMD.*
- 3. The shipment number in the following sequence: Two alpha-character generator site designator code assigned by DOE/NV-WMD (see Appendix D in the NVO-325[Rev.1]); one alpha-character for type of waste L for LLW, M for MW, T for TRU, or X for TRUMW; two numerical characters for current fiscal year; three numerical characters for shipment sequence.*
- 4. Package number shall be six characters (alpha, numeric, or combination) with no duplication within that shipment.*
- 5. Approved 13-digit waste stream identification number (see Section 5.1 in NVO-325[Rev.1])*
- 6. Package weight in units of pounds and kilograms. (NVO-325[Rev.1] Section 5.5.1.3.1)*

Compliance Method:

1. All waste packages will be marked and labeled in accordance with 49 CFR 172, Subparts D and E. Refer to *LLW QA Plan*.
2. An NV-211 "Packaging Certification" label will be completed and signed by the Waste Certification Official or Waste Certification Alternate and affixed to each container. Refer to *LLW QA Plan*.
3. The shipment number shall consist of eight characters. Shipment number: Site designator (SL) + waste type (L for LLW) + current fiscal year (95) + shipment sequence (001 for first shipment of year, etc.) = SLL95001.
4. Package number shall be six characters (alpha, numeric or both) with no duplication within that shipment (e.g. SL0400, SL0377). Refer to OP471095.
5. The waste stream identification number shall be 13 characters in length. The first four characters will be the DOE-assigned Waste Management Information System (WMIS) generator code and the

remaining nine characters are the generator-assigned waste stream code. Example: ASLL-0004RWTWS.

6. The package weight shall be marked on the container in both pounds and kilograms in characters at least one-half inch in height.

J. Barcoding: *The shipment, package, and waste stream identification numbers shall be barcoded according to the following standards.*

1. Code 39
2. Medium to high density, high density preferred.
3. 1.0" high barcode.
4. Human readable interpretation (HRI) 0.5" high printed below the barcode.
5. Spacing between barcode and HRI will be 0.01".
6. Minimum left and right margin (quiet zone) will be at least 0.25".
7. All barcodes and HRI will be placed on each box or nonstandard package near the top and on opposite sides. Drums will have a total of two barcode labels, one on top of the drum lid and one on the side near the top.
8. Barcodes will be requested from REECo, by SNL/CA prior to shipments to NTS.
9. A sample barcode must be submitted to DOE-NV/WMD prior to the first shipment to ensure that DOE-NV/WMD equipment can be used to read the barcode. (NVO-325[Rev.1] Section 5.5.1.3 J)

Compliance Method: A total of two or (more) barcode labels shall be placed on each metal box near the top and on opposite sides. Drums will have a total of two barcode labels, one on top of the drum lid and one on the side near the top. SNL/CA will request barcodes from DOE-NV/WMD because of low-volume generator status (less than 10 shipments per year). DOE-NV/WMD will be contacted at least one month in advance to arrange for the barcodes.

K. On-Site Transfer: *On-site transfer must be in accordance with NV54XG.1A, NV Radiological Safety Manual, and applicable DOT requirements. For the transfer of unpackaged bulk material having external contamination, that contamination shall be fixed, covered, or contained sufficiently for safe transfer. (NVO-325[Rev.1] Section 5.5.1.3 K)*

Compliance Method: On-site waste transfers will be conducted according to the Sandia National Laboratories Transportation Safety Manual and applicable DOT requirements.

3.5.2 ADDITIONAL CRITERIA FOR MIXED WASTE:

In addition to meeting all of the LLW WAC, mixed waste offered for disposal at the Area 5 RWMS Mixed Waste Management Unit (MWMU) must meet the criteria described below. (NVO-325[Rev.1] Section 5.5.2)

Compliance Method: Not applicable to this waste stream.

3.5.3 ADDITIONAL CRITERIA FOR TRANSURANIC WASTE:

Request for storage of all TRU waste will be considered on a case-by-case basis only. (NVO-325[Rev.1] Section 5.5.3)

Compliance Method: Not applicable to this waste stream.

3.5.4 ADDITIONAL CRITERIA FOR BULK WASTE:

Bulk waste is waste which is disposed of in Area 3. It generally exists in a form not suited to the conventional packaging requirements of Area 5. In addition to meeting the LLW WAC, bulk LLW must meet the requirements of Title 49 CFR 173.425(c). Bulk containers must be approved by DOE/NV. (NVO-325[Rev.1] Section 5.5.4)

Compliance method: Bulk waste shall be shipped to the NTS on a case by case basis. DOE/NV and REECO will be contacted prior to shipment to coordinate final disposal guidelines.

All waste items will meet the requirements of title 49 CFR 173.425(c). All bulk waste will be transported in accordance with NV54XG.1, "DOE/NV Radiological Safety Manual," and applicable DOT requirements.

3.5.5 ADDITIONAL CRITERIA FOR CASE-BY-CASE WASTE:

In addition to meeting LLW WAC, the following case-by case types offered for disposal at the NTS must meet the criteria described below. (NVO-325[Rev.1]Section 5.5.5).

3.5.5.1 WEIGHT:

Packages exceeding 4,082kg (9,000pounds) require crane or large forklift removal and must be approved prior to shipment. Shipments of this type must be in a removable-top trailer or removable-side trailer and will incur additional operational costs for the generator (NVO-325[Rev.1]Section 5.5.5.1).

Compliance Method: SNL/CA will seek guidance and approval from DOE/NV and REECO prior to shipment of oversized containers.

3.5.5.2 ACTIVITY LIMITS:

Activity limits outside the range of (NVO-325[Rev.1]Section 5.5.5.2.F shall meet requirements of Title 10 CFR 61 (see (NVO-325[Rev.1]Section 5.5.5.4). Material requiring remote handling will incur additional operational costs for the generator. (NVO-325[Rev.1]Section 5.5.5.2)

Compliance Method: The activity limits listed in Title 49 CFR 173.431, "Activity Limits for Type A and Type B Packages" shall be met. Activity limits outside the range of NVO 325, Rev. 1, section 5.5.1.2.F shall meet the requirements of Title 10 CFR 61. Refer to OP471587, *Characterization of Radioactivity in Waste*.

3.5.5.3 RADIOACTIVELY CONTAMINATED ASBESTOS:

All regulated asbestos that is friable or otherwise capable of giving off friable asbestos dust must be wetted with a waste and surfactant mix and stored in two plastic bags whose combined thickness equals at least 6 mil. The plastic bags must be overpacked in a leak-resistant wood or metal container that meets applicable shipping requirements for the radioactive content of the package involved. Sharp edges and corners within the package shall be padded or otherwise protected to prevent damage to the plastic inner wrap during handling, shipping, and disposal. Because the asbestos must be wetted during abatement activities, an absorbent must be added to ensure compliance with the free liquid requirement for LLW, see NVO-325[Rev.1]Section 5.5.1.1.C.

For further reference on regulated asbestos, see 40 CFR 61.140-61.157 and state-of-generation regulations. All LLW containing regulated asbestos shall be packaged, marked, and labeled in accordance with the requirements of 40 CFR 61.150.

Compliance Method: Not applicable, this waste stream does not contain friable asbestos.

Asbestos-containing materials (greater than one weight percent friable asbestos) will not be shipped to NTS. Refer to Bldg. 968 OP471578. These materials may be classified as category I non-friable asbestos containing materials (ACM) and as category II non-friable ACM per 40CFR61.140. This material is not classified as regulated Asbestos containing material (RACM) because it is managed in such a way to prevent the ACM from becoming friable.

3.5.5.4 DOE COMPARABLE GREATER-THAN-CLASS-C AS DEFINED IN 10 CFR 61.55: (NVO-325 [Rev.1] Section 5.5.5.4):

Compliance Method: Not applicable.

3.5.5.5 CLASSIFIED WASTE STREAMS:(NVO-325 [Rev.1] Section 5.5.5.5.):

Compliance Method: Not applicable.

3.5.5.6 RADIOACTIVE ANIMAL CARCASSES: (NVO-325 [Rev.1]
Section 5.5.5.6):

Compliance Method: Not applicable.

3.5.5.7 OTHER WASTE FORMS: (NVO-325 [Rev.1] Section 5.5.5.7):

Compliance Method: Not applicable.

3.6 WASTE STREAM CHARACTERIZATION DATA SHEET

Waste Stream Characterization Data Sheet

1. Waste Stream No.: A S L L - 0 0 0 4 R W T W S
2. Waste Description: This waste stream (ASLL-0004RWTWS) consists of tritium contaminated items such as experimental hardware, piping, glassware, gloveboxes, manifolds, and containers, personal protective equipment, lab trash and waste such as ethylene glycol and water solidified on clay.
 - a. Physical Characteristic: Waste is solid.
 - b. Special Handling/Disposal Requirements: Not a classified waste stream. Oversized boxes will be sent following NTS guidelines prior to shipment.
3. Basis for Characterization:
 - a. Process Knowledge: X
 - b. Analytical Knowledge:
 - c. Both:

If B or C, provide Standardized Data Reporting Forms as necessary.

4. Radioactive Characteristics:
 - a. Is Waste > NRC Class C (see Title 10 CFR 61.55)?: No
 - b. WMIS Nuclide Category (underline): 1 2 3 4 (5) NA 7 8
(Choose the highest predominate nuclide. The number 6 is not an option.)
 - c. Radioactive Constituents:

		Specific Activity Range of Waste Stream			
	<u>Nuclide</u>	<u>Chemical Forms</u>	<u>Low</u>	<u>Mean</u>	<u>High (Units)</u>
(1)	^3H	HTO, DTO	0	10	100 Ci/kg

5. Hazardous Components (for MW): None

3.8 PACKAGING AND SHIPPING INFORMATION

Include the DOT proper shipping name, hazard class, and hazard identification number (NVO-325[Rev.1], Section 5.8)

Compliance Method: All waste shipments to the NTS will be made in accordance with applicable DOT, EPA, state and local hazardous materials regulations and DOE/NV requirements.

The DOT proper shipping names used for this waste stream are:

- 1) Radioactive Material, n.o.s., 7, UN 2982
- 2) Radioactive Material, Low Specific Activity, n.o.s., 7, UN2912

3.9 WASTE SECURITY INFORMATION

Provide information regarding any special security requirements (NVO-325, [Rev.1], Section 5.9)

Compliance Method: No security requirements necessary.

5.0 EXEMPTION REQUESTS

5.1 Type of Exemption Requested

Valve Removal

A waiver is requested stating that it is not necessary to remove pressure container and manifold valves, but to document by procedure and signed verification by the SNL/CA QA Official for each waste item on the actual waste disposal tag, that the pressure container/manifold internal pressure has been emptied to less than 1.5 atmospheres at 20°C. This method (1) allows for direct venting, de-pressurization of the container/vessel without the potential of personnel radioactive tritium gas exposure, and (2) is in keeping with mandated DOE prudent ALARA (As Low As Reasonable Achievable) principles and practices. Even when a tritium vessel is de-pressurized there is a certain amount of residual tritium that remains in the vessel. If the valve stem is removed, the cylinder will continue to emit tritium to the atmosphere and possibly result in personnel becoming exposed. By allowing the valve stem to remain on the vessel, SNL/CA seeks to avoid unnecessary or accidental venting of tritium to the atmosphere.

The waste packaging procedure, OP471344, *Manifolds and Container, Waste Packaging* provides details about the handling of these waste items. The procedure to check for internal pressure verification is performed by the QA Official found in Appendix C of OP471344.

Water Containing <33% Ethylene Glycol

A waiver is requested stating that it is not necessary to sample the ethylene glycol sub-waste stream. This sub-waste is a samplable, homogeneous waste however, low-volume, unnecessary costs, and detailed process knowledge documentation and verification make sampling an unnecessary effort. The SNL/CA signed verification will provide the QA that the water containing ethylene glycol (<33% by volume) is less than 20 Curies of tritium, liquid volume is less than 16.5 liters and the 15 gallon drum contents are in solid form prior to packaging in a 55 gallon drum. The waste packaging procedure OP471403, *Low-Level Waste (Radioactive) Liquid Solidification* provide details on the handling and verification of this sub-waste.

SNL/CA believes that waste sampling is an unnecessary expense for this waste and that the knowledge about the process which generates this waste is sufficient to justify the use of process knowledge for waste characterization. SNL/CA feels that this situation fits the NVO-325 (Rev.1), Section 4.1, statement; "2) to address those circumstances where sampling and analysis is not feasible or necessary". This simple process which consists of passing a sample of the facility room air through a glass cylinder filled with reagent grade ethylene glycol is well enough understood that sampling and analysis is unnecessary.

The process which generates the 25 percent ethylene glycol waste solution is the result of sampling the ventilation air from the TRL. This is the same air breathed by the workers who occupy the facility and is clean outside air which has passed through the ventilated spaces of an occupied building. There is no reason to believe that this gas stream contains any hazardous materials. Furthermore, there is no reason to believe that the 25 percent ethylene glycol in water solution which results from this environmental monitoring process contains any hazardous materials. Refer to memorandum from W.R. Wall, "Tritium Research Laboratory, Ethylene Glycol, Process Knowledge Documentation", January 21, 1994.

This process generates a very small volume of waste. Approximately 52.8 liters of liquid solution will be generated during the remaining life of the TRL (2-3 years). Due to DOE-NVO-325 packaging requirements this 52.8 liters of liquid solution will be solidified on clay and will result in the generation of less than 4 - 55 gallon drums of solid waste. Tritium quantity is approximately 7.26×10^{-7} Curies of tritium per 55 gallon drum.

A 55 gallon drum of this waste contains tritium at a weight concentration of approximately 6.6×10^{-16} grams of tritium per gram of waste. These quantities indicate the low tritium concentration present.

5.1.1 Duration of Exemption

These exemptions are requested for the duration of the clean up and transition of the Tritium Research Laboratory (2-3 years).

5.1.2 Corrective Action Schedule - Not Applicable

6.0. PROCEDURES AND SUPPORTING DOCUMENTATION

6.1 Procedures and Documentation Referenced in the Application

The SNL/CA waste management program is defined and controlled by the following procedures that are referenced in this *LLW Management Plan*:

- *Low-Level Radioactive Waste - Quality Assurance Plan*
- *ES&H Manual Supplement, "Guidelines for Hazardous Waste Generators at SNL/CA," (GN470075)*
- *SNL ES&H Manual*
- *QA Management Plan*
- *Waste Management Training Plan*
- *Health Physics Training Plan*
- *Sandia National Laboratories Pollution Prevention Plan*
- SP485007, *Low-Level Radioactive Waste and Mixed Waste, Building 961(U)*
- SP472690, *Low-Level Radioactive Waste Storage, Building 968, Room 129(U)*
- OP471102, *Waste Container Receipt Inspection*
- OP471103, *Facility/Equipment Inspection Verification*
- OP WM09, *Radioactive Waste Information System Database*
- OP WM13, *Compaction of Radioactive Waste with the NUPAC model WCI8000 Compactor*
- OP471125, *Non-Conforming or Condemned Item Identification, Form Logging and Tracking*
- OP471095, *Packaging and Storage of Radioactive Waste in the Radioactive & Mixed Waste Storage Facility/Building 961*
- OP471094, *Radioactive Waste Pickup and Transportation*
- OP471578, *Process Knowledge Evaluation for Facility-Specific Waste Streams*
- OP471063, *Operating Procedure for Control of 8642 Document Control*
- OP471347, *Records Management*
- OP471345, *Procurement*
- OP471433, *Administrative Procedure for Certification of Waste*
- IP 10.01, *Independent Assessment*
- IP 5.01, *Control of Technical Data*
- IP 5.03, *Control of Measuring and Test Equipment*
- IP 2.01, *Qualifications and Training*
- W.R. Wall, *"Tritium Research Laboratory, Ethylene Glycol, Process Knowledge, Documentation," January 21, 1994*
- *Sandia National Laboratories Transportation Safety Manual*

The above procedures provide instructions to waste management and health physics for the accomplishment of each activity involved in the processing of radioactive waste. All radioactive waste operations are planned by the Environmental Protection Department and/or the Health Protection Department. The *LLW QA Plan* and the *LLW Management Plan* have been approved by the ES&H, Facilities and Security Center Director.

Procedures used by personnel in Bldg.968 (formerly the Tritium Research Laboratory [TRL]) and Health Physics are as follows:

- OP471080, *TRL, Solid, Non-Compactible, Low-Level Waste (Radioactive) Disposal*
- OP471403, *TRL, Low-Level Waste (Radioactive) Liquid Solidification*
- OP471384, *TRL, Oversize Container, Waste Packaging*
- OP471344, *TRL, Manifolds and Containers, Waste Packaging*
- OP471587, *Characterization of Radioactivity in Waste*
- OPHP10, *Health Physics Counting Procedures*
- IP 5.03, *Control of Measuring and Test Equipment*
- SP472690, *Low-Level Radioactive Waste Storage, Building 968, Room 129(U).*
- SP472823, *Tritium Research Laboratory, Vacuum Effluent Recovery System*
- SP472818, *Tritium Research Laboratory, Nitrogen Backfilled Sealed Gloveboxes*
- SP472824, *Tritium Research Laboratory, Gas Purification System*
- SP472825, *Tritium Research Laboratory, Assay Station*
- *Radiation Instrument Program Requirements for Radiation Protection Instrumentation*
- *Engineering Procedure, Calibration Program.*

6.2 Procedures and Documentation Submitted Along With the Application

The following documents are being submitted to DOE/NV as a separate, uncontrolled supporting reference to the application.

- *ES&H Manual Supplement, "Guidelines for Hazardous Waste Generators at SNL/CA"*
- OPHP10, *Health Physics Counting Procedures*
- OP471587, *Characterization of Radioactivity in Waste*
- OP471433, *Administrative Procedure for Certification of Waste*
- OP471578, *Process Knowledge Evaluation for Facility-Specific Waste Streams*
- OP471095, *Packaging and Storage of Radioactive Waste in the Radioactive & Mixed Waste Storage Facility/Building*
- OP471125, *Non-Conforming or Condemned Item Identification, Form Logging and Tracking*
- OP471080, *TRL Solid, Non-Compactable, Low-Level Waste (Radioactive) Disposal*
- OP471403, *TRL, Low-Level Waste (Radioactive) Liquid Solidification*
- OP471384, *TRL, Oversize Container, Waste Packaging*
- OP471344, *TRL, Manifolds and Containers, Waste Packaging*

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