**Design Demonstrations for Category B Tank Systems
at Oak Ridge National Laboratory, Oak Ridge, Tennessee**

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ACRONYMS

ACI	American Concrete Institute
AEC	Atomic Energy Commission
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
CFM	Cubic Feet per Minute
CRSI	Concrete Reinforcing Steel Institute
DOE	Department of Energy
EPA	Environmental Protection Agency
FFA	Federal Facility Agreement
HEPA	High Efficiency Particulate Air
ISA	Instrument Society of America
JIC	Joint Industrial Council
LLLW	Liquid Low-Level Waste
MVST	Melton Valley Storage Tank
NFPA	National Fire Protection Association
ORNL	Oak Ridge National Laboratory
PVC	Polyvinyl Chloride
PWTF	Process Waste Treatment Facility
QA	Quality Assurance
SAMA	Scientific Apparatus Manufacturers Association
SS	Stainless Steel
TDEC	Tennessee Department of Environment and Conservation
TRU	Transuranic

1. INTRODUCTION

This document presents design demonstrations conducted of liquid low-level waste (LLLW) storage tank systems located at the Oak Ridge National Laboratory (ORNL). ORNL is part of the U. S. Department of Energy's (DOE) Oak Ridge Reservation located southwest of the city of Oak Ridge, Tennessee. The laboratory has conducted research in energy related fields since 1943. The facilities used to conduct the research include nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities. These facilities have produced a variety of radioactive and/or hazardous wastes. These wastes have been stored and transported through an extensive network of piping and tankage.

Demonstration of the design of these tank systems has been stipulated by the Federal Facility Agreement (FFA) between the U. S. Environmental Protection Agency (EPA) — Region IV; the Tennessee Department of Environment and Conservation (TDEC); and the DOE. The FFA establishes four categories of tanks. These are:

Category A -	New or Replacement Tank Systems with Secondary Containment
Category B -	Existing Tank Systems with Secondary Containment
Category C -	Existing Tank Systems without Secondary Containment
Category D -	Existing Tank Systems without Secondary Containment that are
Removed from Service

This document provides a design demonstration of the secondary containment and ancillary equipment of 11 tank systems listed in the FFA as Category "B." The design demonstration for each tank is presented in Section 2. The design demonstrations were developed using information obtained from the design drawings (as-built when available), construction specifications, and interviews with facility operators. The assessments assume that each tank system was constructed in accordance with the design drawings and construction specifications for that system unless specified otherwise. Each design demonstration addresses system conformance to the requirements of the FFA (Appendix F, Subsection C).

2. SUMMARY ASSESSMENT

Individual design demonstrations of the secondary containment systems of 11 FFA Category "B" tank systems are included in Sections 2.1 through 2.11. As additional information is identified for a specific tank system, the section containing the assessment of that tank containment system may be revised and reissued.

The objective of each assessment is to demonstrate that the design of the secondary containment system meets the requirements of Appendix F, Subsection C of the FFA. The assessment concludes that the secondary containment systems of the 11 tank systems evaluated meet the requirements of the FFA.

2.1 Tank W21, Evaporator Service Tank

2.1.1 Tank Summary

Tank W21 is a 50,000-gal, horizontal tank located near the LLW Evaporator (Building 2531) and near the center of the main Bethel Valley Complex (see Figures 2.1-1 and 2.1-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W21 is used as a concentrate collection tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.1.2 Standards for Design Demonstration

2.1.2.1 Tank Description and Design Standards

Tank Description

Tank W21 is located north of Evaporator Building 2531 with Tank C2 located directly south. The ORNL coordinates for Tank W21 center lines are N21935 and E30566.5. The Evaporator Service Tank Area consists of Tanks W21, W22, W23, C1, and C2.

Tank W21 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal, straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W21 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

UCC-ND Engineering Standards Y-EF-538

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Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment

ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

**Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65**

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.1.2.2 Generic Description of Tank Contents

Tank W21 was designed to serve as an evaporator feed tank, but due to a general lack of storage capacity in the Melton Valley Tank Farm Complex, Tank W21 has also been used as a Process Waste Treatment Plant concentrate storage tank and as a liquid low-level waste (LLLW) concentrate storage tank (see Figure 2.1-3). LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste which is then transferred to the LLW Evaporator Feed Tank W22 (and formerly Tank W21). Any waste found to be acidic is adjusted to basic with sodium hydroxide in the generator collection tanks or in the evaporator feed tank. This pH adjustment causes most of the transuranic waste components and heavy metals to precipitate out of solution.

The liquid waste supernate is single phase and ranges in color from pale to deep yellow with sodium/potassium nitrate salt solutions. The principal metals found in the tank sludges are sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce radiation levels of 1.0 to 1.5 rem per hour (R/h) (see Figure 2.1-4).

The analytical data (see Figure 2.1-5) of waste samples are representative of the waste received by Tank W21; however, the composition of the waste stored in Tank W21 may vary depending upon the experiments conducted by the waste generators.

2.1.2.3 Corrosion Protection Measures

Tank W21 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.1.2.4 Documented Age

Tank W21 came on line in 1980 as an evaporator feed tank with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.1.3 Standards for Containment/Release Detection

2.1.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W21 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge 304L SS (1/16") (see Figure 2.1-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.1.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W21 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.1-7). The tank vault foundation is a 39' 0" wide by 73' 0" long by 4' 3" thick reinforced concrete base slab. The tank vault floor elevation is 779' 10" which is 27' 8" below finished grade. The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.1.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W21 is located in a 304L SS-lined vault. Any leakage from Tank W21 flows by gravity to a sump where any accumulation will be detected by a level detector and an alarm sounded in the local Evaporator Service Tanks Control Room, Evaporator Control Room, and Waste Operations Control Center Building 3130.

2.1.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W21 vault bottom slopes to a 2' 0" long by 2' 0" wide by 1' 0" deep 304L SS-lined sump (30 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W21 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.1.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W21 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W21 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 0" by 16' 0" by 7' 0" high (from finished vault floor) and provides a containment volume of 56,130 gallons compared with a nominal full tank content of 50,000 gal for Tank W21.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of the largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the Tank W21 vault provides for surface water runoff to prevent any build up of surface water during rainfall events. Site grades around the Tank W21 vault slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.1-8). Finished grades around the Tank W21 vault structure are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 3' 0" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation

is 779' 10" which is 27' 8" below finished grade. The maximum water table elevation at Tank W21 vault is 802.88' per Well No. 563 measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the evaporator service tank footer drain sump that contains a level indicator and pump for transfer of liquid to the process waste system or storm water sewer.

The 3' 0" thick reinforced concrete vault roof slab is sloped to channel water to a drainage collection system minimizing water buildup. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W21 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, are embedded in concrete, a protective film, known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W21 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. An explosive atmosphere

detector and an alarm system are provided for Tank W21 with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary system for Tank W21 is a 200 CFM ventilation system provided by an existing fan and stack located at Building 3039 (Central Stack Area). Double filtration of the offgas exhaust with the first being a high efficiency particulate air (HEPA) filter located at the tank and final filtration through the existing Building 2534 HEPA filters and Building 3092 HEPA Filters and Scrubber System. Tank W21 primary system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet air is provided to the tank and is filtered through a roughing filter and a single HEPA filter (see Figure 2.1-9).

The ventilation system for the Tank W21 secondary containment provides for six air changes per hour (700 CFM) and ties into the existing cell ventilation duct upstream of the existing filter pit at Building 2533. The secondary containment ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet supply air is provided to the secondary containment through a pre-filter with no HEPA filtration (see Figure 2.1-9).

2.1.4 Supplemental Information

2.1.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W21 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively, and is appropriate for this application.

2.1.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities, which includes the Evaporator Services Tanks W21 through W23 and Waste Storage Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)
ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify specific requirements have been satisfied, and prompt resolution of quality related problems.

2.1.4.3 Ancillary Equipment

Single wall piping and transfer pumps associated with Tank W21 are located within the confines of the vault system, with any leaking fluid captured in SS-lined sumps and pumped by a steam ejector to the Evaporator Service Tanks W22 and W23. Piping and related equipment (such as steam jet ejectors, valving, and pipe supports) are fabricated from 304L SS which is the same material as Tank W21 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W21; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W21 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.1.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine

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wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W21.

2.1.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

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ORNL Site Map

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FIGURE 2.1-2
Layout Of The Evaporator Service Tanks

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FIGURE 2.1-3
Schematic Of The Liquid Low-Level Waste System

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**FIGURE 2.1-4
General Characteristics Of Waste Samples**

Liquid samples			Sludge samples		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-21	0.300	No	2/soft sludge	1.0-1.5	Sonicated sludge: consistency of prepared mustard; medium yellow with dark flecks
W-23	0.120	No	3/soft sludge	1.0-2.5	Top sample (W23-S1): smooth, brownish-yellow paste; 2.5 R/h Sonicated sludge: consistency of prepared mustard; medium brown with dark flecks

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EBASCO/MAIN

FIGURE 2.1-5
Analytical Data For Liquid And Sludge Samples

ANALYTICAL DATA FOR LIQUID SAMPLE			ANALYTICAL DATA FOR SLUDGE SAMPLE		
TANK			TANK		
Characteristics	JAN., 1990	W2-L2	Characteristics	JAN., 1990	W2-L3
Physical properties and measurements data					
TDS (1)	(mg/L)	383	TS (2)	(mg)	511
TS (2)	(mg/L)	431	Density	(g/mL)	1.40
Density	(g/mL)	1.204	IC (3)	(mg/kg)	13000
IC (3)	(mg/L)	<1.8	TC (4)	(mg/kg)	18300
TC (4)	(mg/L)	371	TOC (5)	(mg/kg)	6400
TOC (5)	(mg/L)	371	ECRA metals		
Ag	(mg/L)	1.1	Ag	(mg/kg)	(30)
As	(mg/L)	2.8	Al	(mg/kg)	(47)
Ba	(mg/L)	33	Ba	(mg/kg)	78
Cd	(mg/L)	2.9	Cd	(mg/kg)	27
Cr	(mg/L)	2	Cr	(mg/kg)	160
Hg	(mg/L)	0.92	Hg	(mg/kg)	36
Mn	(mg/L)	15	Mn	(mg/kg)	75
Pb	(mg/L)	7.1	Pb	(mg/kg)	299
Sr	(mg/L)	<2.3	Sr	(mg/kg)	<23
Tl	(mg/L)	<0.94	Tl	(mg/kg)	<10
ECRA metals			ECRA metals		
Al	(mg/L)	<1.1	Al	(mg/kg)	3900
B	(mg/L)	1.9	B	(mg/kg)	<6.6
Ca	(mg/L)	23000	Ca	(mg/kg)	47000
Co	(mg/L)	.	Cu	(mg/kg)	.
Fe	(mg/L)	340	Fe	(mg/kg)	2300
K	(mg/L)	28000	K	(mg/kg)	8300
Mg	(mg/L)	5880	Mg	(mg/kg)	3600
Mn	(mg/L)	41800	Ni	(mg/kg)	49000
Si	(mg/L)	<1	Sr	(mg/kg)	300
Sr	(mg/L)	160	Th	(mg/kg)	13700
Th	(mg/L)	95.0	U	(mg/kg)	31000
U	(mg/L)	750	Radioactive isotopes		
Chloride	(B)	0.029	Gamma alpha	(Bq/g)	1.27e+03
Fluoride	(B)	<0.033	Gamma beta	(Bq/g)	2.34e+06
Nitrate	(B)	1.8	¹⁴ C	(Bq/g)	1.80e+02
Phosphate	(B)	<0.003	¹⁴ Cu	(Bq/g)	<2.5e+04
Sulfate	(B)	<0.003	⁶⁰ Co	(Bq/g)	8.07e+04
Alkalinity			¹³⁷ Co	(Bq/g)	4.99e+03
pH		* 6.56	¹³⁷ Ca	(Bq/g)	2.49e+03
H ⁺	(B)	8003	¹³⁷ Eu	(Bq/g)	1.20e+06
OH ⁻	(B)	.	¹³⁷ Eu	(Bq/g)	<3.7e+05
CO ₃ ²⁻	(B)	.	¹³⁷ Eu	(Bq/g)	1.20e+05
HCO ₃ ⁻	(B)	.	¹³⁷ Eu	(Bq/g)	<1.4e+01
Radioactive isotopes			¹³⁷ Eu	(Bq/g)	1.20e+05
Gamma alpha	(Bq/L)	2.14e+03	¹³⁷ Eu	(Bq/g)	<1.4e+01
Gamma beta	(Bq/L)	4.99e+03	¹³⁷ Eu	(Bq/g)	1.20e+05
¹⁴ C	(Bq/L)	<1.0e+00	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹⁴ Cu	(Bq/L)	<1.5e+03	¹³⁷ Eu	(Bq/g)	1.20e+05
⁶⁰ Co	(Bq/L)	8.36e+03	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Co	(Bq/L)	1.12e+03	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Ca	(Bq/L)	3.19e+03	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	3.31e+04	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	1.46e+04	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	5.25e+03	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	3.50e+02	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	<1.5e+02	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	1.95e+03	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	2.46e+04	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	<1.5e+01	¹³⁷ Eu	(Bq/g)	<1.4e+01
Alpha isotopes			¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	4.80e+01	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	3.94e+02	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	6.20e+01	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	2.61e+02	¹³⁷ Eu	(Bq/g)	1.20e+05
¹³⁷ Eu	(Bq/L)	1.14e+00	¹³⁷ Eu	(Bq/g)	<1.4e+01
¹³⁷ Eu	(Bq/L)	1.14e+00	¹³⁷ Eu	(Bq/g)	1.20e+05

LEGEND: PHYSICAL PROPERTIES
(1) TSD-TOTAL DISSOLVED SOLIDS
(2) TS - TOTAL SOLIDS
(3) IC - INORGANIC CARBON
(4) TC - TOTAL CARBON
(5) TOC-TOTAL ORGANIC CARBON

* JUNE 1990
6.9 pH

LEGEND: PHYSICAL PROPERTIES
(1) TSD - TOTAL DISSOLVED SOLIDS
(2) TS - TOTAL SOLIDS
(3) IC - INORGANIC CARBON
(4) TC - TOTAL CARBON
(5) TOC - TOTAL ORGANIC CARBON

Figure 2.1-6 Tank Vault Stainless Steel Liner

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EBASCO/MAIN

2.1-19

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Figure 2.1-8 Tank Vault Grading Plan

21-20

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EBASCO/MAN

Figure 2.1-9 Tank W-21 H & V Diagram

2.1-21

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EBASCO/MAIN

2.2 Tank W22, Evaporator Service Tank

2.2.1 Tank Summary

Tank W22 is a 50,000-gal, horizontal tank located near the LLW Evaporator (Building 2531) and near the center of the main Bethel Valley Complex (see Figures 2.2-1; 2.2-2; 2.2-3; and 2.2-4). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W22 is used as a LLW Evaporator Feed Tank and is classified as an FFA Category "B" tank.

2.2.2 Standards for Design Demonstration

2.2.2.1 Tank Description and Design Standards

Tank Description

Tank W22 is located north of Evaporator Building 2531 with Tank C2 located directly south. The ORNL coordinates for Tank W22 center lines are N21935 and E30554.5. The Evaporator Service Tank Area consists of Tanks W21, W22, W23, C1, and C2.

Tank W22 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W22 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

UCC-ND Engineering Standards Y-EF-538

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Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

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American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.2.2.2 Generic Description of Tank Contents

Tank W22 was designed as a liquid low-level waste (LLLW) collection tank for the main ORNL complex in Bethel Valley and Melton Valley. The waste solution generators are "hot" sinks and drains in Research and Development Laboratories, Radiochemical Pilot Plants, and Nuclear Reactors located at ORNL. The waste solutions discharged from the source Buildings are stored and monitored in collection tanks that are distributed throughout the ORNL complex. LLLW from the collection tanks are transferred to the Evaporator Feed Tank W22 via an underground header system for processing at the low level waste evaporator with Tank W23 collecting the concentrated waste after processing (see Figure 2.2-5).

The liquid waste supernate is single phase and ranges in color from pale to deep yellow with a high pH (11-13) sodium/potassium nitrate salt solutions. The principal metals found in the tank are sodium, potassium, calcium, magnesium, uranium and thorium with a low level of aluminum and iron. The sludge contains radioactive materials that produce radiation levels of approximately 1.0 to 2.0 rem per hour (R/h).

The analytical data (see Figures 2.2-6 and 2.2-7) of waste solution samples from the generators are representative of waste received by Tank W22; however, the composition of the waste transferred to and stored in Tank W22 may vary depending upon the experiments conducted by the waste generators.

2.2.2.3 Corrosion Protection Measures

Tank W22 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and project 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.2.2.4 Documented Age

Tank W22 came on line in 1980 as an evaporator feed tank with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.2.3 Standards for Containment/Release Detection

2.2.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W22 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figures 2.2-8 and 2.2-9). The selection of vault lining materials is appropriate for the service in which it is used.

2.2.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W22 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.2-10). The tank vault foundation is a 39' 0" wide by 73' 0" long by 4' 3" thick reinforced concrete base slab. The tank vault floor elevation is 779' 10" which is 27' 8" below finished grade. The tank vault base slab is set on limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.2.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W22 is located in a 304L SS-lined vault. Any leakage from Tank W22 flows by gravity to a sump where any accumulation will be detected by a level detector and an alarm sounded in the local Evaporator Service Tanks Control Room, Evaporator Control Room, and Waste Operations Control Center Building 3130.

2.2.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W22 vault bottom slopes to a 2' 0" long by 2' 0" wide by 1' 0" deep 304L SS-lined sump (30 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W22 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.2.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W22 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W22 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 0" by 16' 0" by 7' 0" high (from finished vault floor) and provides a containment volume of 56,130 gallons compared with a nominal full tank content of 50,000 gal for Tank W22.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of the largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the Tank W22 vault provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the Tank W22 vault slope away from the tank vault, conveying rainwater to storm drain catch basin inlets (see Figure 2.2-11). Finished grades around the Tank W22 vault structure are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 3' 0" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation

is 779' 10" which is 27' 8" below finished grade. The maximum water table elevation at Tank W22 vault is 802.88' per Well No. 563 measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the evaporator service tank footer drain sump that contains a level indicator and pump for transfer of liquid to the process waste system or storm water sewer.

The 3' 0" thick reinforced concrete vault roof slab is sloped to channel water to a drainage collection system minimizing water buildup. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure (see Figure 2.2-10).

Water Stops

Tank W22 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W22 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. An explosive atmosphere

detector and an alarm system are provided for Tank W22 with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary system for Tank W22 is a 200 CFM ventilation system provided by an existing fan and stack located at Building 3039 (Central Stack Area). Double filtration of the offgas exhaust with the first being a high efficiency particulate air (HEPA) filter located at the tank and final filtration through the existing Building 2534 HEPA filters and Building 3092 HEPA Filters and Scrubber System. Tank W22 primary system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet air is provided to the tank and is filtered through a roughing filter and a single HEPA filter (see Figure 2.2-12).

The ventilation system for the Tank W22 secondary containment provides for six air changes per hour (700 CFM) and ties into the existing cell ventilation duct upstream of the existing filter pit at Building 2533. The secondary containment ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet supply air is provided to the secondary containment through a pre-filter with no HEPA filtration (see Figure 2.2-12).

2.2.4 Supplemental Information

2.2.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W22 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.2.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities, which includes the Evaporator Services Tanks W21 through W23 and Waste Storage Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)
ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preoperational and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.2.4.3 Ancillary Equipment

Single wall piping and transfer pumps associated with Tank W22 are located within the confines of the vault system, with any leaking fluid captured in SS-lined sumps and pumped by a steam ejector to the Evaporator Service Tanks W21 and W23. Piping and related equipment (such as steam jet ejectors, valving, and pipe supports) are fabricated from 304L SS, which is the same material as Tank W22 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W22; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W22 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.2.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine

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wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W22.

2.2.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.2.6 References

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Energy Systems Drawing - Evaporator Service Tanks Piping Flow Diagram - Service P-20237-YE-080-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Plan, Elevation & Nozzle Schedule S-20237-YB-016-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Plan & Sections & Details Stainless Steel Liner S-20237-YB-035-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Tank Piping Sections & Details SHT#2 Tanks W21, W22, & W23 P-20237-YC-031-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Tank Piping Section & Details SHT#3 P-20237-YC-032-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Plan Piping Tanks W21, W22, And W23 P-20237-YC-028-E, Rev. 3

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**FIGURE 2.2-1
ORNL Site Plan**

REV. 0 10-11-91

FIGURE 2.2-2
Location Of Major LLW Facilities At ORNL

REV. 0 10-11-91

FIGURE 2.2-3
Location Of The ILW Evaporators, Building 2531

REV. 0 10-11-91

FIGURE 2.2-4
Layout Of The Evaporator Service Tanks

REV. 0 10-11-91

FIGURE 2.2-5
Schematic Of The Liquid Low-Level Waste System

REV. 0 10-11-91

FIGURE 2.2-6
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

Characteristic JAN. 1990 * W22 REPRESENTATIVE SAMPLE			Characteristic JAN. 1990 * W23 REPRESENTATIVE SAMPLE		
<u>Physical properties and microchemical data</u>			<u>Physical properties and microchemical data</u>		
TDS (mg/L)		381	TS (mg/L)		324
TS (mg/L)		383	Density (g/mL)		1.34
Density (g/mL)		1.2423	IC (mg/kg)		18100
IC (mg/L)		8340	TC (mg/kg)		22200
TC (mg/L)		9300	TOC (mg/kg)		4120
TOC (mg/L)		1160			
<u>BCRA metals</u>			<u>BCRA metals</u>		
Ag (mg/L)		<0.44	Ag (mg/kg)		(28)
As (mg/L)		<3.8	As (mg/kg)		(<38)
Ba (mg/L)		<0.19	Ba (mg/kg)		43
Cd (mg/L)		1.7	Cd (mg/kg)		32
Cr (mg/L)		0.42	Cr (mg/kg)		190
Hg (mg/L)		0.07	Hg (mg/kg)		19
Mn (mg/L)		3.0	Ni (mg/kg)		110
Pb (mg/L)		2.7	Pb (mg/kg)		(450)
Se (mg/L)		<2.3	Se (mg/kg)		<39
Tl (mg/L)		<0.34	Tl (mg/kg)		<16
<u>Trace metals</u>			<u>Trace metals</u>		
Al (mg/L)		1.8	Al (mg/kg)		2800
B (mg/L)		10	B (mg/kg)		<10
Ca (mg/L)		10	Ca (mg/kg)		57000
Co (mg/L)		.	Co (mg/kg)		
Fe (mg/L)		8.70	Fe (mg/kg)		1900
K (mg/L)		30000	K (mg/kg)		18000
Mg (mg/L)		3.4	Mg (mg/kg)		16000
Na (mg/L)		82000	Na (mg/kg)		82000
Si (mg/L)		<1	Se (mg/kg)		290
Sr (mg/L)		0.40	Tb (mg/kg)		12000
Tb (mg/L)		13.8	U (mg/kg)		13000
U (mg/L)		17			
<u>Anions</u>			<u>Anions</u>		
Chloride (M)		0.10			
Fluoride (M)		<0.003			
Nitrate (M)		3.23			
Phosphate (M)		<0.013			
Sulfate (M)		0.061			
<u>Alkalinity</u>			<u>Alkalinity</u>		
pH		12.8			
H ⁺ (M)		.			
OH ⁻ (M)		0.15			
CO ₃ ²⁻ (M)		0.70			
HCO ₃ ⁻ (M)					
<u>Radioisotope content</u>			<u>Radioisotope content</u>		
Gross alpha (Bq/mL)		3.20e+01	Gross alpha (Bq/g)		2.20e+01
Gross beta (Bq/mL)		4.82e+01	Gross beta (Bq/g)		4.87e+01
¹⁴ C (Bq/mL)		4.35e+01	¹⁴ C (Bq/g)		3.63e+01
¹⁴ C _{org} (Bq/mL)		<1.0e+01	¹⁴ C _{org} (Bq/g)		<2.7e+01
⁶⁰ Co (Bq/mL)		6.21e+01	⁶⁰ Co (Bq/g)		2.52e+01
¹³⁷ Co (Bq/mL)		4.63e+01	¹³⁷ Co (Bq/g)		4.63e+01
¹³⁷ Co (Bq/mL)		4.36e+01	¹³⁷ Co (Bq/g)		4.36e+01
¹³⁷ Eu (Bq/mL)		<2.1e+01	¹³⁷ Eu (Bq/g)		4.92e+01
¹³⁷ Eu (Bq/mL)		<1.6e+01	¹³⁷ Eu (Bq/g)		7.22e+01
¹³⁷ Eu (Bq/mL)		<0.5e+01	¹³⁷ Eu (Bq/g)		5.14e+01
¹³⁷ Eu (Bq/mL)		1.19e+01	¹³⁷ Eu (Bq/g)		1.21e+01
¹³⁷ Eu (Bq/mL)		<1.0e+01	¹³⁷ Eu (Bq/g)		<7.8e+01
¹³⁷ Eu (Bq/mL)		3.78e+01	¹³⁷ Eu (Bq/g)		<6.2e+01
¹³⁷ Eu (Bq/mL)		4.13e+01	¹³⁷ Eu (Bq/g)		2.28e+01
¹³⁷ Eu (Bq/mL)		<1.0e+01	¹³⁷ Eu (Bq/g)		<4.3e+01
<u>Alpha emitters</u>			<u>Alpha emitters</u>		
²³⁸ U (Bq/mL)		4.00e+00	²³⁸ U (Bq/g)		1.10e+01
²³⁸ U (Bq/mL)		6.00e+00	²³⁸ U (Bq/g)		<2.0e+01
²³⁸ U (Bq/mL)		6.00e+00	²³⁸ U (Bq/g)		1.10e+01
²³⁸ U (Bq/mL)		3.90e+01	²³⁸ U (Bq/g)		3.21e+01
²³⁸ U (Bq/mL)		4.00e+00	²³⁸ U (Bq/g)		<2.4e+01
			²³⁸ U (Bq/g)		1.67e+01

* NO DATA FOR TANK W22, TANK W23 SHOWN AS A REP. SAMPLE

LEGEND:

TSD - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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FIGURE 2.2-7

Radiochemical Analyses In The Evaporator Service Tanks

Radiochemical analyses of beta emitters in the Evaporator Service Tanks^a

Tank	Sample date	Sample location	Gross beta		Gross gamma (c/min-ML)	Sr-90	Cs-137	Co-60	Eu-152	Eu-154	Eu-155	Zr-95	Nb-95
			TRU ^b	RNAL ^c									
W-21	Nov. 85	Solids ^d	84,900	68,300	1.49E+07	16,400	6,760	1,060	11,600	5,840	2,400	2,660	200
W-22	Nov. 85	Solids ^d	56,500	33,700	1.18E+07	10,200	5,050	740	10,900	5,350	2,060	2,920	120
W-23	Nov. 85	Liquid ^d	66,800	49,800	1.25E+07	9,400	2,040	760	11,000		2,250		200
	Nov. 85	Solids ^d	237,000	205,000	1.35E+07	73,700	6,510	880	12,100	8,220	2,550	3,400	

^aAll data from the TRU laboratory except RNAL gross beta and Sr-90.^bTRU data: Request No. 45764, received 1/30/86, completed 2/6/86.^cRNAL data: Request No. 34529, received 11/12/85, completed 11/22/85.^dnCi/g for solid samples.^enCi/mL for liquid samples.^fA blank space means no data available.Radiochemical analyses of alpha emitters
in the Evaporator Service Tanks^a

Tank	Sample date	Sample location	Gross alpha		Cm-244	Am-241	Pu-239 & Pu-240	Pu-238	U-233
			TRU ^b	RNAL ^c					
W-21	Nov. 85	Solids ^d	5110	1900	010	70	380	030	50
W-22	Nov. 85	Solids ^d	3510	2260	1100	100	190	280	58
W-23	Nov. 85	Liquid ^d	870	710	280	50	50	90	38
	Nov. 85	Solids ^d	6970	3190	2190	<30	580	500	130

^aAll data from the TRU laboratory except RNAL gross alpha.^bTRU data: Request No. 45764, received 1/30/86, completed 2/6/86.^cRNAL data: Request No. 34529, received 11/12/85, completed 11/22/85.^dnCi/g for solid samples.^enCi/mL for liquid samples.

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**Figure 2.2-8
Tank Vault Stainless Steel Liner**

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Figure 2.2-9
Tank Vault Stainless Steel Liner Details

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Figure 2.2-12 Tank W-22 H & V Diagram

2.3 Tank W23, Evaporator Service Tank

2.3.1 Tank Summary

Tank W23 is a 50,000-gal, horizontal tank located near the LLW Evaporator (Building 2531) and near the center of the main Bethel Valley Complex (see Figures 2.3-1; 2.3-2; 2.3-3; and 2.3-4). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W23 is used as a concentrate collection tank (Evaporator Bottoms) for the LLW Evaporator and is classified as an FFA Category "B" tank.

2.3.2 Standards for Design Demonstration

2.3.2.1 Tank Description and Design Standards

Tank Description

Tank W23 is located north of Evaporator Building 2531 with Tank C2 located directly south. The ORNL coordinates for Tank W23 center lines are N21935 and E30512.5. The Evaporator Service Tank Area consists of Tanks W21, W22, W23, C1, and C2.

Tank W23 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge(wg)].

Design Standards

The applicable codes and standards used for Tank W23 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation.

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.3.2.2 Generic Description of Tank Contents

Tank W23 was designed as a concentrate storage tank for the Low Level Waste Evaporator in the Bethel Valley complex.

Liquid low-level waste (LLLW) is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the LLW Evaporator Feed Tank W22. The waste is concentrated by processing in the LLW Evaporator by a batch operation until a predetermined specific gravity is reached. After processing, the evaporator bottoms are pumped directly into Tank W23 for storage with the ability to transfer from Tank W23 to additional Concentrate Storage Tanks C1, C2, and W24 through W31 (see Figure 2.3-5).

The liquid waste supernate is single phase and ranges in color from pale to deep yellow with a high pH (11-13) sodium/potassium nitrate salt solutions.

A sludge layer with a depth of 52" is located in the tank bottom. The sludge is soft with a consistency of prepared mustard and medium brown in color with dark flecks. The principal metals found in the tank sludge are sodium, potassium, calcium, magnesium, uranium, and thorium with a low level of aluminum and iron. The sludge contains radioactive materials that produce radiation levels of 1.0 to 2.5 rem per hour (R/h) (see Figure 2.3-6).

The analytical data (see Figure 2.3-7) of waste solution samples from the generators are representative of waste received by Tank W23; however, the composition of the waste transferred to and stored in Tank W23 may vary depending upon the experiments conducted by the waste generators.

2.3.2.3 Corrosion Protection Measures

Tank W23 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.3.2.4 Documented Age

Tank W23 came on line in 1980 as an evaporator feed tank with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.3.3 Standards for Containment/Release Detection

2.3.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W23 is constructed of ASME SA-240, type 304L plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figures 2.3-8; 2.3-9; and 2.3-10). The selection of vault lining materials is appropriate for the service in which it is used.

2.3.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W23 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.3-9). The tank vault foundation is a 21' 0" wide by 73' 0" long by 4' 3" thick reinforced concrete base slab. The tank vault floor elevation is 788' 6" which is 19' 0" below finished grade. The tank vault base slab is set on a limestone rock foundation with rock removed (approximately 4' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.3.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W23 is located in a 304L SS-lined vault. Any leakage from Tank W23 flows by gravity to a sump where any accumulation will be detected by a level detector and an alarm sounded in the local Evaporator Service Tanks Control Room, Evaporator Control Room, and Waste Operations Control Center Building 3130.

2.3.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W23 vault bottom slopes to a 2' 0" long by 2' 0" wide by 1' 0" deep 304L SS-lined sump (30 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W23 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.3.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W23 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W23 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 69' 0" by 16' 0" by 7' 0" high (from finished vault floor) and provides a containment volume of 57,805 gal compared with a nominal full tank content of 50,000 gal for Tank W23.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of the tank.

Infiltration

Site and storm drainage design around the perimeter of the Tank W23 vault provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the Tank W23 vault slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.3-11). Finished grades around the Tank W23 vault structure are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 3' 0" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 779' 10" which is 27' 8" below finished grade. The maximum water table elevation at Tank W23 vault is 802.88' per Well No. 563 measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the evaporator service tank footer drain sump that contains a level indicator and pump for transfer of liquid to the process waste system or storm water sewer.

The 3' 0" thick reinforced concrete vault roof slab is sloped to channel water to a drainage collection system minimizing water buildup. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure (see Figure 2.3-9).

Water Stops

Tank W23 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, are embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts

like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W23 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. An explosive atmosphere detector and an alarm system are provided for Tank W23 with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary system for Tank W23 is a 100 CFM ventilation system provided by an existing fan and stack located at Building 3039 (Central Stack Area). Double filtration of the offgas exhaust with the first being a high efficiency particulate air (HEPA) filter located at the tank and final filtration through the existing Building 2534 HEPA filters and Building 3092 HEPA Filters and Scrubber System. Tank W23 primary system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet air is provided to the tank and is filtered through a roughing filter and a single HEPA filter (see Figure 2.3-12).

The ventilation system for the Tank W23 secondary containment provides for 6 air changes per hour (350 CFM) and ties into the existing cell ventilation duct upstream of the existing filter pit at Building 2533. The secondary containment ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. Fresh inlet supply air is provided to the secondary containment through a pre-filter with no HEPA filtration (see Figure 2.3-12).

2.3.4 Supplemental Information

2.3.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W23 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.3.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities, which includes the Evaporator Services Tanks W21 through W23 and Waste Storage Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing pre-operational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.3.4.3 Ancillary Equipment

Single wall piping and transfer pumps associated with Tank W23 are located within the confines of the vault system, with any leaking fluid captured in SS-lined sumps and pumped by an ejector type jet pump utilizing steam as a working fluid to the Evaporator Service Tanks W21 and W22. Piping and related equipment (such as steam jet ejectors, valving, and pipe supports) are fabricated from 304L SS, which is the same material as Tank W23 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W23; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W23 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.3.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W23.

2.3.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.3.6 References

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Energy Systems Drawing - Evaporator Service Tanks Instrument Flow Diagram I-20237-YE-105-E, Rev. 3, Title I issue

Energy Systems Drawing - Evaporator Service Tanks Piping Flow Diagram - Process P-20237-YE-079-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Piping Flow Diagram - Service P-20237-YE-080-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Plan, Elevation & Nozzle Schedule S-20237-YB-016-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Plan & Sections & Details Stainless Steel Liner S-20237-YB-035-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Tank Piping Sections & Details SHT#2 Tanks W21, W22, & W23 P-20237-YC-031-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Tank Piping Section & Details SHT#3 P-20237-YC-032-E, Rev. 2

Energy Systems Drawing - Evaporator Service Tanks Plan Piping Tanks W21, W22, and W23 P-20237-YC-028-E, Rev. 3

Energy Systems Drawing - Evaporator Service Tanks Piping Sections & Details Tanks W21, W22 and W23 P-20237-YC-029-E, Rev. 3

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FIGURE 23-1
ORNL Site Plan

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FIGURE 2.3-2
Location Of The LLW Facilities At ORNL

Location of major LLW facilities at ORNL.

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FIGURE 2.3-3
Location Of The ILW Evaporators, Building 2531

Location of the ILW Evaporators, Building 2531.

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FIGURE 2.3-4
Layout Of The Evaporator Service Tanks

Layout of the Evaporator Service Tanks.

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FIGURE 2.3-5
Schematic Of The Liquid Low-Level Waste System

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FIGURE 2.3-6
General Characteristics Of Waste Samples

Liquid samples:			Sludge samples		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-21	0.300	No	2/soft sludge	1.0-1.5	Sonicated sludge: consistency of prepared mustard; medium yellow with dark flecks
W-23	0.120	No	3/soft sludge	1.0-2.5	Top sample (W23-S1): smooth, brownish-yellow paste; 2.5 R/h Sonicated sludge: consistency of prepared mustard; medium brown with dark flecks

FIGURE 2.3-7
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristic	JAN. 1990	W21-L1
Physical properties and microchemical data		
TDS (mg/L)		381
TS (mg/L)		383
Density (g/mL)		1.2473
IC (mg/L)		8340
TC (mg/L)		9500
TOC (mg/L)		1160
ECRA metals		
Ag (mg/L)		<0.44
As (mg/L)		<1.0
Ba (mg/L)		<0.19
Cd (mg/L)		1.7
Cr (mg/L)		0.42
Hg (mg/L)		0.07
Ni (mg/L)		3.0
Pb (mg/L)		2.7
Se (mg/L)		<2.1
Tl (mg/L)		<0.94
Trace metals		
Al (mg/L)		1.3
B (mg/L)		10
Ca (mg/L)		18
Co (mg/L)		-
Fe (mg/L)		0.70
K (mg/L)		18000
Mg (mg/L)		3.4
Na (mg/L)		82000
Si (mg/L)		<1
Sr (mg/L)		0.40
Zn (mg/L)		15.8
U (mg/L)		17
Anions		
Chloride (M)		0.10
Fluoride (M)		<0.053
Nitrate (M)		1.25
Phosphate (M)		<0.053
Sulfate (M)		0.081
Alkalinity		
pH		12.8
H ⁺ (M)		-
OH ⁻ (M)		0.15
CO ₃ ²⁻ (M)		0.70
HCO ₃ ⁻ (M)		-
Radioisotope analysis		
Gross alpha (Bq/L)		5.30e+01
Gross beta (Bq/L)		4.82e+05
¹³⁷ Cs (Bq/L)		4.35e+01
¹³⁷ Cs (Bq/L)		<1.6e+03
⁶⁰ Co (Bq/L)		4.21e+02
¹³⁷ Cs (Bq/L)		4.63e+03
¹³⁷ Cs (Bq/L)		4.36e+05
¹³⁷ Cs (Bq/L)		<2.1e+02
¹³⁷ Cs (Bq/L)		<1.6e+02
¹³⁷ Cs (Bq/L)		<1.3e+02
¹³⁷ Cs (Bq/L)		1.17e+02
¹³⁷ Cs (Bq/L)		<1.0e+02
¹³⁷ Cs (Bq/L)		1.70e+03
¹³⁷ Cs (Bq/L)		4.13e+01
¹³⁷ Cs (Bq/L)		<1.0e+02
Alpha emitters		
²³⁸ U (Bq/L)		4.00e+00
²³⁵ U (Bq/L)		6.00e+00
²³² Th/ ²³² Pa (Bq/L)		6.00e+00
²³² Th/ ²³² Pa (Bq/L)		3.90e+01
²³² Th (Bq/L)		4.00e+00

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

Characteristic	JAN. 1990	W20-S
Physical properties and microchemical data		
TS (mg/L)		544
Density (g/mL)		1.34
IC (mg/L)		18188
TC (mg/L)		21285
TOC (mg/L)		4120
ECRA metals		
Ag (mg/L)		(28)
As (mg/L)		<1.0
Ba (mg/L)		43
Cd (mg/L)		22
Cr (mg/L)		190
Hg (mg/L)		89
Ni (mg/L)		110
Pb (mg/L)		<150
Se (mg/L)		<30
Tl (mg/L)		<16
Trace metals		
Al (mg/L)		2800
B (mg/L)		<10
Ca (mg/L)		50000
Co (mg/L)		-
Fe (mg/L)		1900
K (mg/L)		18000
Mg (mg/L)		16000
Na (mg/L)		62000
Sr (mg/L)		290
Tb (mg/L)		12000
U (mg/L)		17000
Radioisotope analysis		
Gross alpha (Bq/L)		2.25e+02
Gross beta (Bq/L)		6.67e+06
¹³⁷ Cs (Bq/L)		3.63e+02
¹³⁷ Cs (Bq/L)		<2.7e+04
⁶⁰ Co (Bq/L)		2.52e+02
¹³⁷ Cs (Bq/L)		2.65e+03
¹³⁷ Cs (Bq/L)		4.95e+05
¹³⁷ Cs (Bq/L)		7.22e+05
¹³⁷ Cs (Bq/L)		3.84e+05
¹³⁷ Cs (Bq/L)		1.25e+05
¹³⁷ Cs (Bq/L)		<7.0e+03
¹³⁷ Cs (Bq/L)		<6.3e+04
¹³⁷ Cs (Bq/L)		2.28e+06
¹³⁷ Cs (Bq/L)		<4.5e+04
Alpha emitters		
²³⁸ U (Bq/L)		1.18e+04
²³⁵ U (Bq/L)		<2.8e+04
²³² Th (Bq/L)		1.18e+04
²³² Th/ ²³² Pa (Bq/L)		3.21e+04
²³² Th (Bq/L)		<2.6e+04
²³² Th (Bq/L)		1.67e+05

LEGEND:

TSD - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.3-8
Tank Vault Stainless Steel Liner

REV. 1 07-20-92

EBASCO/MAIN

Figure 2.3-9
Tank Vault Concrete Details

REF. DWG. S-20237-YB-035E REV2

REV. 1 07-20-92

ERASCO/MAIN

REF.DWG. S-20237-YB-035E, REV. 2

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Figure 2.3-11 Tank Vault Grading Plan

2.4 Tank W24, Melton Valley Storage Tank

2.4.1 Tank Summary

Tank W24 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.4-1 and 2.4-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W24 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.4.2 Standards for Design Demonstration

2.4.2.1 Tank Description and Design Standards

Tank Description

Tank W24 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W25, W26, and W27, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W24 center lines are N 16584.25 and E 27974. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W24 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W24 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards.

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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DESIGN DEMONSTRATIONS - CATEGORY B LLLW TANK SYSTEMS

ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications - Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.4.2.2 Generic Description of Tank Contents

Tank W24 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W24 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W24 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W31 for storage (see Figure 2.4-3).

The liquid waste supernate in Tank W24 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W24 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce a radiation level of 1.2 rem per hour (R/h) (see Figure 2.4-4).

The analytical data (see Figure 2.4-5) of waste samples are representative of the waste received by Tank W24; however, the composition of the waste stored in Tank W24 may vary depending upon the experiments conducted by the waste generators.

2.4.2.3 Corrosion Protection Measures

Tank W24 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.4.2.4 Documented Age

Tank W24 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.4.3 Standards for Containment/Release Detection

2.4.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W24 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.4-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.4.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W24 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.4-7). Tank W24 shares the vault structure with Tanks W25, W26, and W27 and is one of eight tanks (W24 through W31) that are located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783'3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.4.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W24 is located in a 304L SS-lined vault. Any leakage from Tank W24 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.4.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W24 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W24 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.4.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W24 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W24 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault, leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W24 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W24 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W24 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.4-8). Finished grades around the vault containing Tank W24 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W24 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W24 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, are embedded in concrete, a protective film, known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating which precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W24 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.4-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W24 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W24 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W24, W25, W26, and W27. The fresh air is drawn through Tank W24 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W24 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W24 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W24 vault is a 1400 CFM fresh air ventilation system for the Tanks W24, W25, W26, and W27 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.4.4 Supplemental Information

2.4.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W24 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively, and is appropriate for this application.

2.4.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing pre-operational and start-up testing of equipment and systems, compilation and maintenance of QA records and data generated to verify specific requirements have been satisfied, and prompt resolution of quality related problems.

2.4.4.3 Ancillary Equipment

Single wall piping associated with Tank W24 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST's Tanks W24 through W31. Piping and related equipment such as pumps, jet ejectors, valving, and pipe supports are fabricated from 304L SS which is the same material as Tank W24 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W24; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W24 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.4.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W24.

2.4.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.4.6 References

Binford, F.T. and S. D. ORFL. 1979. *The Intermediate Level Liquid Waste System at the Oak Ridge National Laboratory Description and Safety Analysis*. Oak Ridge National Laboratory. ORNL/TM-6959.

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Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E

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Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F

Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G

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EBASCO SERVICES INCORPORATED REV: 2
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DESIGN DEMONSTRATIONS - CATEGORY B LLLW TANK SYSTEMS

Samborn, Steketee, Otis, and Evans, Inc. July 1975. *Intermediate Level Waste Management Facilities Design Calculations (Sheets 1 To 69) Tanks W21 Through W31.* Oak Ridge National Laboratory.

Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis.* Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

Location Of Melton Valley Storage Tank Facility At ORNL

REV.0 10-11-91

FIGURE 2.4-2
Layout Of The Melton Valley Storage Tanks

REV. 0 10-11-91

FIGURE 2.4-3
Schematic Of The Liquid Low-Level Waste System

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**FIGURE 2.4-4
General Characteristics Of Waste Samples**

Liquid samples				Sludge samples	
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-24	0.180	No	2 soft sludge	1.2	Could probably pump with a peristaltic pump, except for the thin layer of "mud" on bottom Sanitized sludge: light yellow tan; very fine particles with a few coarser particles
W-25	0.260	No	3 soft sludge	1.3	Thicker sludge than in tank W-24 Could probably pump with a peristaltic pump, except for the thin layer of "mud" on bottom Sanitized sludge: light tan; very fine particles with a few coarser particles

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EBASCO/MAIN

FIGURE 2.4-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

	TANK
Characteristic JAN. 1990	W24-L2
Physical properties and microchemical data	
TDS (mg/L)	377
TS (mg/L)	383
Density (g/L)	1.2348
IC (mg/L)	1918
TC (mg/L)	2408
TOC (mg/L)	489
ECRA metals	
Ag (mg/L)	<0.07
As (mg/L)	<1.7
Ba (mg/L)	6.29
Cd (mg/L)	0.21
Cr (mg/L)	3.1
Hg (mg/L)	0.046
Mn (mg/L)	<0.38
Pb (mg/L)	6.7
Se (mg/L)	<4.7
Ti (mg/L)	<1.4
Trace metals	
Al (mg/L)	46
B (mg/L)	6.99
Ca (mg/L)	7.2
Co (mg/L)	<0.57
Fe (mg/L)	<2.6
K (mg/L)	11800
Mg (mg/L)	<1.3
Na (mg/L)	180000
Ni (mg/L)	345
Sr (mg/L)	<0.34
Th (mg/L)	<2.2
U (mg/L)	9.4
Anions	
Chloride (M)	0.073
Fluoride (M)	<0.026
Nitrate (M)	4.19
Phosphate (M)	<0.007
Sulfate (M)	<0.002
Acidity	
pH	11.1
H ⁺ (M)	-
OH ⁻ (M)	0.29
CO ₃ ²⁻ (M)	0.13
HCO ₃ ⁻ (M)	<0.06
Radioactive isotopes	
Gross alpha (Bq/L)	5.80e+08
Gross beta (Bq/L)	2.78e+05
¹³⁷ Cs (Bq/L)	1.97e+03
¹³⁴ Co (Bq/L)	<7.4e+02
¹³⁷ Co (Bq/L)	3.29e+02
¹³⁴ Co (Bq/L)	1.34e+03
¹³⁷ Co (Bq/L)	2.21e+05
¹³⁷ Eu (Bq/L)	<3.2e+02
¹³⁷ Eu (Bq/L)	<6.8e+01
¹³⁷ Eu (Bq/L)	<4.8e+02
¹³⁷ Eu (Bq/L)	3.08e+02
¹³⁷ Eu (Bq/L)	<2.8e+02
¹³⁷ Eu (Bq/L)	<1.1e+03
¹³⁷ Eu (Bq/L)	9.13e+02
¹³⁷ Eu (Bq/L)	<5.8e+02

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

	TANK
Characteristic JAN. 1990	W24-S
Physical properties and microchemical data	
TS (mg/L)	487
Density (g/L)	1.26
IC (mg/L)	6630
TC (mg/L)	9530
TOC (mg/L)	2940
ECRA metals	
Ag (mg/L)	(<1.7)
As (mg/L)	<4.2
Ba (mg/L)	44
Cd (mg/L)	6.1
Cr (mg/L)	34
Hg (mg/L)	26
Mn (mg/L)	22
Pb (mg/L)	150
Se (mg/L)	<3.7
Ti (mg/L)	<1.4
Trace metals	
Al (mg/L)	1420
B (mg/L)	3.1
Ca (mg/L)	29008
Co (mg/L)	<1.3
Fe (mg/L)	400
K (mg/L)	7808
Mg (mg/L)	3608
Na (mg/L)	69008
Sr (mg/L)	118
Th (mg/L)	1480
U (mg/L)	3700
Radioactive isotopes	
Gross alpha (Bq/L)	2.34e+04
Gross beta (Bq/L)	2.62e+06
¹³⁷ Cs (Bq/L)	8.02e+02
¹³⁴ Co (Bq/L)	<3.9e+03
¹³⁷ Co (Bq/L)	3.39e+04
¹³⁴ Co (Bq/L)	<6.2e+02
¹³⁷ Co (Bq/L)	1.96e+05
¹³⁷ Eu (Bq/L)	6.20e+04
¹³⁷ Eu (Bq/L)	3.60e+04
¹³⁷ Eu (Bq/L)	1.80e+04
¹³⁷ Eu (Bq/L)	<5.6e+02
¹³⁷ Eu (Bq/L)	<5.7e+03
¹³⁷ Eu (Bq/L)	1.85e+06
¹³⁷ Eu (Bq/L)	<2.8e+03
Alpha emitters	
²³⁸ U (Bq/L)	-
²³⁵ U (Bq/L)	5.13e+02
²³⁴ U (Bq/L)	<3.7e+03
²³⁸ U (Bq/L)	1.54e+03
²³⁸ U (Bq/L)	3.74e+03
²³⁸ U (Bq/L)	<3.6e+03
²³⁸ U (Bq/L)	1.62e+04

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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**Figure 2.4-6
Tank Vault Stainless Steel Liner**

REF. DWG.
S-21247-Y6-008-S
REV. B

REV. 1 07-20-92

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Figure 2.4-7 Tank Vault Concrete Details

REF DWG.
S-21247-YB-005-B
REV D

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Figure 2.4-9 Tanks W-24 Through W-27 H & V Diagram

2.4-21

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2.5 Tank W25, Melton Valley Storage Tank

2.5.1 Tank Summary

Tank W25 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.5-1 and 2.5-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W25 is used as a concentrate storage tank for the LLW Evaporator, and is classified as an FFA Category "B" tank.

2.5.2 Standards for Design Demonstration

2.5.2.1 Tank Description and Design Standards

Tank Description

Tank W25 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W24, W26, and W27, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W25 center lines are N 16584.25 and E 27990. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W25 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operate at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W25 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications - Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.5.2.2 Generic Description of Tank Contents

Tank W25 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W25 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W25 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW are generated from a variety of facilities at ORNL including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W31 for storage (see Figure 2.5-3).

The liquid waste supernate in Tank W25 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W25 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce a radiation level of 1.3 rem per hour (R/h) (see Figure 2.5-4).

The analytical data (see Figure 2.5-5) of waste samples are representative of the waste received by Tank W25; however, the composition of the waste stored in Tank W25 may vary depending upon the experiments conducted by the waste generators.

2.5.2.3 Corrosion Protection Measures

Tank W25 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.5.2.4 Documented Age

Tank W25 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.5.3 Standards for Containment/Release Detection

2.5.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W25 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.5-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.5.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W25 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.5-7). Tank W25 shares the vault structure with Tanks W24, W26, and W27 and is one of eight tanks (W24 through W31) that are located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.5.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W25 is located in a 304L SS-lined vault. Any leakage from Tank W25 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.5.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W25 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gallon). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W25 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.5.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W25 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W25 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the other three tanks in the vault leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W25 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W25 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W25 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.5-8). Finished grades around the vault containing Tank W25 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W25 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W25 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W25 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.5-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W25 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W25 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W24, W25, W26, and W27. The fresh air is drawn through Tank W25 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W25 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W25 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W25 vault is a 1400 CFM fresh air ventilation system for the Tanks W24, W25, W26, and W27 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.5.4 Supplemental Information

2.5.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W25 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.5.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.5.4.3 Ancillary Equipment

Single wall piping associated with Tank W25 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS which is the same material as Tank W25 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W25; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W25 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.5.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W25.

2.5.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.5.6 References

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Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

FIGURE 2.5-1
Location Of Melton Valley Storage Tank Facility At ORNL

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FIGURE 2.5-2
Layout Of The Melton Valley Storage Tanks

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**FIGURE 2.5-3
Schematic Of The Liquid Low-Level Waste System**

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**FIGURE 2.5-4
General Characteristics Of Waste Samples**

Liquid samples:			Sludge samples:		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-24	0.180	No	2/soft sludge	1.2	Could probably pump with a peristaltic pump, except for the thin layer of "mud" on bottom Sonicated sludge: light yellow tan; very fine particles with a few coarser particles
W-25	0.280	No	3/soft sludge	1.3	Thicker sludge than in tank W-24 Could probably pump with a peristaltic pump, except for the thin layer of "mud" on bottom Sonicated sludge: light tan; very fine particles with a few coarser particles

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FIGURE 2.5-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

		TANK
Characteristic	JAN. 1990	W23-L3
<u>Physical properties and microchemical data</u>		
TDS (mg/L)		348
TS (mg/L)		335
Density (g/mL)		1.2018
IC (mg/L)		11.5
TC (mg/L)		478
TOC (mg/L)		462
<u>RCRA metals</u>		
Ag (mg/L)		<0.49
As (mg/L)		<3.7
Ba (mg/L)		3.2
Cd (mg/L)		<0.12
Cr (mg/L)		1.9
Hg (mg/L)		0.054
Mn (mg/L)		0.45
Pb (mg/L)		<2.1
Se (mg/L)		<2.7
Ti (mg/L)		<1.4
<u>Trace metals</u>		
Al (mg/L)		<1.2
B (mg/L)		0.60
Cu (mg/L)		280
Co (mg/L)		<0.37
Fe (mg/L)		<2.6
K (mg/L)		17000
Mg (mg/L)		<1.3
Na (mg/L)		18000
Si (mg/L)		<1
Sr (mg/L)		23
Th (mg/L)		<2.2
U (mg/L)		<0.10
<u>Anions</u>		
Chloride (M)		0.071
Fluoride (M)		<0.026
Nitrate (M)		4.19
Phosphate (M)		<0.013
Sulfate (M)		<0.012
<u>Acidity</u>		
pH		12.3
H ⁺ (M)		0.06
OH ⁻ (M)		<0.81
CO ₃ ²⁻ (M)		<0.81
HCO ₃ ⁻ (M)		<0.81
<u>Radiochemical analysis</u>		
Gross Alpha (Bq/L)		2.80e+00
Gross Beta (Bq/L)		3.92e+03
²³⁸ Pu (Bq/L)		3.25e+01
²³⁹ Pu (Bq/L)		<1.3e+03
²⁴⁰ Pu (Bq/L)		1.80e+03
²⁴¹ Pu (Bq/L)		3.79e+03
²⁴² Pu (Bq/L)		3.27e+05
²⁴³ Pu (Bq/L)		<1.4e+02
²⁴⁴ Pu (Bq/L)		<1.2e+02
²⁴⁵ Pu (Bq/L)		<6.9e+02
²⁴⁶ Pu (Bq/L)		3.05e+02
²⁴⁷ Pu (Bq/L)		<6.3e+01
²⁴⁸ Pu (Bq/L)		<1.9e+03
²⁴⁹ Pu (Bq/L)		1.95e+04
²⁵⁰ Pu (Bq/L)		<1.2e+02

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

		TANK
Characteristic	JAN. 1990	W23-S
<u>Physical properties and microchemical data</u>		
TS (mg/L)		531
Density (g/mL)		1.32
IC (mg/L)		3920
TC (mg/L)		6250
TOC (mg/L)		2370
<u>RCRA metals</u>		
Ag (mg/L)		<1.0
As (mg/L)		<4.1
Ba (mg/L)		59
Cd (mg/L)		11
Cr (mg/L)		59
Hg (mg/L)		37
Mn (mg/L)		34
Pb (mg/L)		220
Se (mg/L)		<1.1
Ti (mg/L)		<16
<u>Trace metals</u>		
Al (mg/L)		2800
B (mg/L)		<1.3
Cu (mg/L)		36000
Co (mg/L)		<1.3
Fe (mg/L)		946
K (mg/L)		9200
Mg (mg/L)		5900
Na (mg/L)		44000
Sr (mg/L)		150
Th (mg/L)		2650
U (mg/L)		4800
<u>Radiochemical analysis</u>		
Gross Alpha (Bq/L)		4.65e+04
Gross Beta (Bq/L)		4.00e+06
²³⁸ Pu (Bq/L)		1.71e+02
²³⁹ Pu (Bq/L)		<4.3e+03
²⁴⁰ Pu (Bq/L)		4.03e+04
²⁴¹ Pu (Bq/L)		7.05e+02
²⁴² Pu (Bq/L)		2.35e+05
²⁴³ Pu (Bq/L)		8.14e+04
²⁴⁴ Pu (Bq/L)		5.06e+04
²⁴⁵ Pu (Bq/L)		1.62e+04
²⁴⁶ Pu (Bq/L)		<3.9e+02
²⁴⁷ Pu (Bq/L)		<3.8e+03
²⁴⁸ Pu (Bq/L)		1.65e+06
²⁴⁹ Pu (Bq/L)		<4.6e+03
<u>Alpha emitters</u>		
²³⁵ U (Bq/L)		8.37e+02
²³⁸ U (Bq/L)		<4.3e+03
²³² Th (Bq/L)		2.92e+03
²³² Th/ ²³² Pa (Bq/L)		2.35e+03
²³² Th/ ²³² Pa/ ²³² Ac (Bq/L)		<1.9e+03
²³² Th/ ²³² Pa/ ²³² Ac/ ²³² Bi (Bq/L)		2.32e+04

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.5-6
Tank Vault Stainless Steel Liner

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Figure 2.5-7 Tank Vault Concrete Details

Figure 2.5-8 Tank Vault Grading Plan

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2.6 Tank W26, Melton Valley Storage Tank

2.6.1 Tank Summary

Tank W26 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.6-1 and 2.6-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W26 is used as a concentrate storage tank for the LLW Evaporator and is classified as an FFA Category "B" tank.

2.6.2 Standards for Design Demonstration

2.6.2.1 Tank Description and Design Standards

Tank Description

Tank W26 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W24, W25, and W27, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W26 center lines are N 16584.25 and E 28006. The MVST Facility consist of eight storage tanks numbered W24 through W31.

Tank W26 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F, and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W26 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.6.2.2 Generic Description of Tank Contents

Tank W26 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W26 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W26 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W31 for storage (see Figure 2.6-3).

The liquid waste supernate in Tank W26 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W26 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce radiation levels of 0.8 to 2.0 rem per hour (R/h) (see Figure 2.6-4).

The analytical data (see Figure 2.6-5) of waste samples are representative of the waste received by Tank W26; however, the composition of the waste stored in Tank W26 may vary depending upon the experiments conducted by the waste generators.

2.6.2.3 Corrosion Protection Measures

Tank W26 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.6.2.4 Documented Age

Tank W26 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.6.3 Standards for Containment/Release Detection

2.6.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W26 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.6-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.6.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W26 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.6-7). Tank W26 shares the vault structure with Tanks W24, W25, and W27 and is one of eight tanks (W24 through W31) located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.6.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W26 is located in a 304L SS-lined vault. Any leakage from Tank W26 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.6.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W26 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W26 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.6.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W26 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W26 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault, leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W26 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W26 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W26 slope away from the tank vault, conveying rainwater to storm drain catch basin inlets (see Figure 2.6-8). Finished grades around the vault containing Tank W26 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W26 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W26 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating which precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W26 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.6-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. An explosive atmosphere detector and an alarm system are provided for Tank W26 and are provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W26 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W24, W25, W26, and W27. The fresh air is drawn through Tank W26 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W26 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W26 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W26 vault is a 1400 CFM fresh air ventilation system for the Tanks W24, W25, W26, and W27 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.6.4 Supplemental Information

2.6.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W26 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.6.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which includes the Evaporator Services Tanks W21 through W23 and The MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.6.4.3 Ancillary Equipment

Single wall piping associated with Tank W26 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS, which is the same material as Tank W26 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W26; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W26 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.6.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W26.

2.6.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.6.6 References

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Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E

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Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F

Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G

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Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis.* Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

FIGURE 2.6-1
Location Of Melton Valley Storage Tank Facility At ORNL

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FIGURE 2.6-2
Layout Of The Melton Valley Storage Tanks

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FIGURE 2.6-3
Schematic Of The Liquid Low-Level Waste System

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**FIGURE 2.6-4
General Characteristics Of Waste Samples**

Liquid samples:				Sludge samples:	
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-25	0.260	No	3/soft sludge	1.3	Thicker sludge than in tank W-24 Could probably pump with a peristaltic pump, except for the thin layer of "mud" on bottom Stratified sludge: light tan; very fine particles with a few coarser particles
W-26	1.200	No	3/soft sludge	0.8-2.0	Top sample (W26-S1): highest radiation level Bottom sample (W26-S3): highest viscosity of the tank samples studied by Lee and Shaw Stratified sludge: dense and plastic with the consistency of peanut butter; gummy particles

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FIGURE 2.6-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristic	JAN, 1990	TANK W24-L2
<u>Physical properties and miscellaneous data</u>		
TDS (mg/L)		349
TS (mg/L)		366
Density (g/mL)		1.2177
IC (mg/L)		2580
TC (mg/L)		3488
TOC (mg/L)		1381
<u>RCRA metals</u>		
Ag (mg/L)		1.2
As (mg/L)		<3.7
Ba (mg/L)		8.30
Cd (mg/L)		4.5
Cr (mg/L)		1.8
Hg (mg/L)		<0.08
Ni (mg/L)		8.2
Pb (mg/L)		2.2
Se (mg/L)		<4.7
Ti (mg/L)		<1.1
<u>Trace metals</u>		
Al (mg/L)		4.6
B (mg/L)		2.9
Ca (mg/L)		20
Co (mg/L)		<0.57
Fe (mg/L)		<2.6
K (mg/L)		\$1000
Mg (mg/L)		3.1
Na (mg/L)		6808
Si (mg/L)		11.9
Sr (mg/L)		<0.74
Zn (mg/L)		18
U (mg/L)		1130
<u>Anions</u>		
Chloride (M)		0.099
Fluoride (M)		<0.026
Nitrate (M)		3.29
Phosphate (M)		<0.053
Sulfate (M)		<0.052
<u>Acid-base</u>		
pH		11.2
H ⁺ (M)		<8.81
OH ⁻ (M)		0.20
CO ₃ ²⁻ (M)		0.02
HCO ₃ ⁻ (M)		
<u>Radioactive analysis</u>		
Gross alpha (Bq/L)		1.00e+01
Gross beta (Bq/L)		2.20e+04
²³² Th (Bq/L)		1.21e+01
²³⁵ U (Bq/L)		<2.3e+00
²³⁸ U (Bq/L)		1.22e+04
²³² Th (Bq/L)		1.31e+04
²³⁵ U (Bq/L)		2.87e+06
²³⁸ U (Bq/L)		<2.1e+02
²³² Th (Bq/L)		<2.4e+02
²³⁵ U (Bq/L)		<1.2e+03
²³⁸ U (Bq/L)		6.88e+02
²³² Th (Bq/L)		<1.4e+02
²³⁵ U (Bq/L)		<2.8e+03
²³⁸ U (Bq/L)		4.90e+02
²³² Th (Bq/L)		<2.3e+01
<u>Alpha analysis</u>		
²³⁵ U (Bq/L)		1.60e+01
²³⁸ U (Bq/L)		9.20e+02
²³² Th (Bq/L)		1.00e+01
²³⁵ U, ²³⁸ U (Bq/L)		1.80e+01
²³² Th, ²³⁵ U (Bq/L)		<1.3e+01

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

Characteristic	JAN, 1990	TANK W24-S
<u>Physical properties and miscellaneous data</u>		
TS (mg/L)		449
Density (g/mL)		1.54
IC (mg/L)		12008
TC (mg/L)		18288
TOC (mg/L)		4228
<u>RCRA metals</u>		
Ag (mg/L)		(80)
As (mg/L)		85
Ba (mg/L)		83
Cd (mg/L)		42
Cr (mg/L)		170
Hg (mg/L)		64
Ni (mg/L)		92
Pb (mg/L)		470
Se (mg/L)		<31
Ti (mg/L)		<17
<u>Trace metals</u>		
Al (mg/L)		7580
B (mg/L)		<7.3
Ca (mg/L)		34000
Co (mg/L)		
Fe (mg/L)		2388
K (mg/L)		3088
Mg (mg/L)		12008
Na (mg/L)		31888
Sr (mg/L)		128
Th (mg/L)		9288
U (mg/L)		24888
<u>Radioactive analysis</u>		
Gross alpha (Bq/L)		9.13e+04
Gross beta (Bq/L)		5.70e+06
²³² Th (Bq/L)		2.13e+02
²³⁵ U (Bq/L)		<1.2e+04
²³⁸ U (Bq/L)		1.83e+05
²³² Th (Bq/L)		2.95e+03
²³⁵ U (Bq/L)		4.83e+05
²³⁸ U (Bq/L)		4.92e+05
²³² Th (Bq/L)		3.19e+05
²³⁵ U (Bq/L)		2.51e+04
²³⁸ U (Bq/L)		<2.5e+04
²³² Th (Bq/L)		2.85e+06
²³⁵ U (Bq/L)		<1.3e+05
<u>Alpha analysis</u>		
²³⁵ U (Bq/L)		6.66e+03
²³⁸ U (Bq/L)		<1.2e+04
²³² Th (Bq/L)		3.11e+03
²³⁵ U, ²³⁸ U (Bq/L)		1.48e+04
²³² Th, ²³⁵ U (Bq/L)		<1.3e+04
²³⁸ U, ²³² Th (Bq/L)		6.14e+04

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.6-6
Tank Vault Stainless Steel Liner

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Figure 2.6-7 Tank Vault Concrete Details

2.6-21

2.7 Tank W27, Melton Valley Storage Tank

2.7.1 Tank Summary

Tank W27 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.7-1 and 2.7-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W27 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.7.2 Standards for Design Demonstration

2.7.2.1 Tank Description and Design Standards

Tank Description

Tank W27 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W24, W25, and W26, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W27 center lines are N 16584.25 and E 27974. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W27 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W27 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural - Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.7.2.2 Generic Description of Tank Contents

Tank W27 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W27 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W27 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tank W24 through W31 for storage (see Figure 2.7-3).

The liquid waste supernate in Tank W27 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W27 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce radiation levels of 0.2 to 0.3 rem per hour (R/h) (see Figure 2.7-4).

The analytical data (see Figure 2.7-5) of waste samples are representative of the waste received by Tank W27; however, the composition of the waste stored in Tank W27 may vary depending upon the experiments conducted by the waste generators.

2.7.2.3 Corrosion Protection Measures

Tank W27 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.7.2.4 Documented Age

Tank W27 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.7.3 Standards for Containment/Release Detection

2.7.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W27 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.7-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.7.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W27 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.7-7). Tank W27 shares the vault structure with Tanks W24, W25, and W26 and is one of eight tanks (W24 through W31) located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting is the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.7.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W27 is located in a 304L SS-lined vault. Any leakage from Tank W27 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.7.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W27 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gallon). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W27 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top preventing accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.7.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W27 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W27 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault, leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W27 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W27 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W27 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.7-8). Finished grades around the vault containing Tank W27 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W27 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W27 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W27 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.7-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W27 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W27 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W24, W25, W26, and W27. The fresh air is drawn through Tank W27 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W27 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W27 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W27 vault is a 1400 CFM fresh air ventilation system for the Tanks W24, W25, W26, and W27 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.7.4 Supplemental Information

2.7.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W27 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.7.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)
ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.7.4.3 Ancillary Equipment

Single wall piping associated with Tank W27 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS which is the same material as Tank W27 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W27; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W27 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.7.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W27.

2.7.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.7.6 References

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Coobs, J.H. and J. R. Gissel. 1986. *History of Disposal of Radioactive Waste into the Ground at Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10269.

Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E

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Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F

Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G

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Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis.* Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

FIGURE 2.7-1
Location Of Melton Valley Storage Tank Facility At ORNL

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FIGURE 2.7-2
Layout Of The Melton Valley Storage Tanks

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**FIGURE 2.7-3
Schematic Of The Liquid Low-Level Waste System**

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**FIGURE 2.7-4
General Characteristics Of Waste Samples**

Liquid samples:				Sludge samples	
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-27	0.160-0.200	No	2/soft sludge	0.2	Sample W27-S2: appearance of small pieces of concrete in a softer sludge
			1/auger bit (soft and hard sludge)	0.3	<p>Soft sludge in auger-bit sampler:</p> <p>(a) Unsonicated: appearance of small pieces of concrete in a softer sludge</p> <p>(b) Sonicated sludge (W27-H1-S): gray and gritty; consistency of cooked oatmeal</p> <p>Hard sludge:</p> <p>(a) Felt like hitting concrete during sampling; on first attempt to collect sample W27-S2, bent closure plate of soft sludge sampler when hit hard layer</p> <p>(b) Consistency like a hard mud; no free liquid; appearance of concrete pieces mixed with mud or clay; too stiff to sonicate</p> <p>General: soft sludge over hard layer; had to cut hard layer with auger-bit sampler; estimated 1 ft thick; below hard layer, about 2-ft thick layer of soft sludge; hard sludge plugged sampler; no sample of underlying soft layer</p>

FIGURE 2.7-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristics	TANK	
	JAN. 1990	W27-L2
<u>Physical properties and identification data</u>		
TDS (mg/L)		358
TS (mg/L)		355
Density (g/mL)		1.2118
IC (mg/L)		4.7
TC (mg/L)		364
TOC (mg/L)		339
<u>ECRA metals</u>		
Ag (mg/L)		<0.09
As (mg/L)		<1.7
Ba (mg/L)		4.1
Cd (mg/L)		0.12
Cr (mg/L)		2.8
Hg (mg/L)		<0.048
Mn (mg/L)		<0.38
Pb (mg/L)		<2.1
Se (mg/L)		<4.7
Ti (mg/L)		<1.4
<u>Trace metals</u>		
Al (mg/L)		<4.2
B (mg/L)		0.67
Ca (mg/L)		3600
Co (mg/L)		<0.37
Fe (mg/L)		<2.6
K (mg/L)		8300
Mg (mg/L)		<1.3
Na (mg/L)		30000
Si (mg/L)		<1.8
Sr (mg/L)		18
Tb (mg/L)		<2.2
U (mg/L)		<0.1
<u>Anions</u>		
Chloride (M)		0.071
Fluoride (M)		<0.006
Nitrate (M)		4.52
Phosphate (M)		<0.053
Sulfate (M)		<0.052
<u>Acidity</u>		
pH		11.8
H ⁺ (M)		8.01
OH ⁻ (M)		<0.01
CO ₃ ²⁻ (M)		<0.01
HCO ₃ ⁻ (M)		<0.01
<u>Radioactive isotopes</u>		
Cesium alpha (Bq/mL)		<1.8e+00
Cesium beta (Bq/mL)		3.38e+05
¹³⁷ Cs (Bq/mL)		1.87e+02
¹³⁴ Cs (Bq/mL)		<1.3e+02
¹³⁷ Co (Bq/mL)		3.89e+02
¹³⁴ Co (Bq/mL)		1.61e+03
¹³⁷ Eu (Bq/mL)		2.14e+03
¹³⁴ Eu (Bq/mL)		<1.1e+03
¹⁵² Eu (Bq/mL)		<6.6e+01
¹⁵⁴ Eu (Bq/mL)		<4.0e+02
¹⁵² Gd (Bq/mL)		2.05e+03
¹⁵⁴ Gd (Bq/mL)		<3.0e+01
¹⁵² Lu (Bq/mL)		<1.1e+03
¹⁵⁴ Lu (Bq/mL)		5.57e+04
¹⁵² Zr (Bq/mL)		<5.2e+01

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

Characteristics	TANK	
	JAN. 1990	W27-H1-S W27-H1-R
<u>Physical properties and identification data</u>		
TS (mg/L)	386	471
Density (g/mL)	1.36	1.33
IC (mg/L)	3258	12700
TC (mg/L)	7898	16300
TOC (mg/L)	2440	3830
<u>ECRA metals</u>		
Ag (mg/L)	<1.3	<1.3
As (mg/L)	<20	<20
Ba (mg/L)	48	72
Cd (mg/L)	13	17
Cr (mg/L)	65	90
Hg (mg/L)	11	18
Mn (mg/L)	27	48
Pb (mg/L)	130	280
Se (mg/L)	<49	<86
Ti (mg/L)	20	<17
<u>Trace metals</u>		
Al (mg/L)	4200	4800
B (mg/L)	<4.4	<13
Ca (mg/L)	38000	54000
Co (mg/L)		
Fe (mg/L)	1400	2300
K (mg/L)	6900	6700
Mg (mg/L)	4900	5700
Na (mg/L)	78000	64000
Sr (mg/L)	128	130
Tb (mg/L)	1890	3040
U (mg/L)	2718	1960
<u>Radioactive isotopes</u>		
Cesium alpha (Bq/L)	2.23e+04	3.38e+04
Cesium beta (Bq/L)	1.44e+06	2.83e+06
¹³⁷ Cs (Bq/L)	<1.89e+02	4.84e+02
¹³⁴ Cs (Bq/L)	<1.6e+03	<7.3e+03
¹³⁷ Co (Bq/L)	1.61e+04	2.58e+04
¹³⁴ Co (Bq/L)	<1.2e+03	<1.8e+03
¹³⁷ Eu (Bq/L)	3.75e+03	5.71e+03
¹³⁴ Eu (Bq/L)	1.95e+04	2.43e+04
¹⁵² Eu (Bq/L)	1.26e+04	1.33e+04
¹⁵⁴ Eu (Bq/L)	<3.4e+03	1.94e+03
¹⁵² Gd (Bq/L)	<7.3e+02	<1.4e+03
¹⁵⁴ Gd (Bq/L)	<1.8e+04	<1.6e+04
¹⁵² Lu (Bq/L)	<5.5e+03	5.53e+03
¹⁵⁴ Lu (Bq/L)	<1.7e+03	<2.6e+03
<u>Alpha emitters</u>		
²³⁸ U (Bq/L)		
²³⁵ U (Bq/L)	5.18e+02	6.38e+02
^{234m} Pa (Bq/L)	<1.8e+03	<1.3e+03
²³⁴ Th (Bq/L)	1.84e+03	1.84e+03
²³⁴ Ac (Bq/L)	4.13e+03	6.73e+03
²³⁸ Am (Bq/L)	<6.5e+03	<1.6e+04
²⁴¹ Am (Bq/L)	1.60e+04	2.13e+04

LEGEND: PHYSICAL PROPERTIES
 TDS - TOTAL DISSOLVED SOLIDS
 TS - TOTAL SOLIDS
 IC - INORGANIC CARBON
 TC - TOTAL CARBON
 TOC - TOTAL ORGANIC CARBON

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Figure 2.7-6
Tank Vault Stainless Steel Liner

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S-21247-YB-002-E
REV. B

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ERASCO/MAIN

Figure 2.7-7 Tank Vault Concrete Details

Figure 2.7-8 Tank Vault Grading Plan

2.7-20

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ERASCO/MAN

Figure 2.7-9 Tanks W-24 Through W-27 H & V Diagram

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EBASCO/MAIN

2.8 Tank W28, Melton Valley Storage Tank

2.8.1 Tank Summary

Tank W28 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.8-1 and 2.8-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W28 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.8.2 Standards for Design Demonstration

2.8.2.1 Tank Description and Design Standards

Tank Description

Tank W28 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W29, W30, and W31, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W28 center lines are N 16584.25 and E 28040.5. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W28 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W28 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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DESIGN DEMONSTRATIONS - CATEGORY B LLLW TANK SYSTEMS

UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications - Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.8.2.2 Generic Description of Tank Contents

Tank W28 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W28 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W28 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W-31 for storage (see Figure 2.8-3).

The liquid waste supernate in Tank W28 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W28 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce a radiation level of 1.2 rem per hour (R/h) (see Figure 2.8-4).

The analytical data (see Figure 2.8-5) of waste samples are representative of the waste received by Tank W28; however, the composition of the waste stored in Tank W28 may vary depending upon the experiments conducted by the waste generators.

2.8.2.3 Corrosion Protection Measures

Tank W28 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.8.2.4 Documented Age

Tank W28 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.8.3 Standards for Containment/Release Detection

2.8.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W28 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.8-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.8.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W28 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.8-7). Tank W28 shares the vault structure with Tanks W29 through W31 and is one of eight tanks (W24 through W31) that are located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.8.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W28 is located in a 304L SS-lined vault. Any leakage from Tank W28 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.8.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W28 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gallon). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W28 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top to prevent accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.8.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W28 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W28 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W28 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W28 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W28 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.8-8). Finished grades around the vault containing Tank W28 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W28 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W28 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W28 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.8-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W28 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W28 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W28, W29, W30, and W31. The fresh air is drawn through Tank W28 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W28 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W28 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W28 vault is a 1400 CFM fresh air ventilation system for the Tanks W28, W29, W30, and W31 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.8.4 Supplemental Information

2.8.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W28 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.8.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify specific requirements have been satisfied, and prompt resolution of quality related problems.

2.8.4.3 Ancillary Equipment

Single wall piping associated with Tank W28 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS, which is the same material as Tank W28 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W28; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W28 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.8.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W28.

2.8.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.8.6 References

Binford, F.T. and S. D. ORFI. 1979. *The Intermediate Level Liquid Waste System at the Oak Ridge National Laboratory Description and Safety Analysis*. Oak Ridge National Laboratory. ORNL/TM-6959.

Coobs, J.H. and J. R. Gissel. 1986. *History of Disposal of Radioactive Waste into the Ground at Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10269.

Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E

Energy Systems Drawing - Waste Storage Tanks, Plan Stainless Steel Liner, Tank Vault, S-21247-YB-008-E, Rev. B

Energy Systems Drawing - Waste Storage Tanks, Sections and Details of Concrete Vault, S-21247-YB-003-E, Rev. D

Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F

Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G

Oak Ridge National Laboratory. 1991. *Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory*. Department of Waste Minimization Planning and Certification. WM-WMCO-201.

Peretz, F.J., B. R. Clark, C. B. Scott, and J. B. Berry. 1986. *Characterization of Low Level Liquid Wastes at the Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10218.

Samborn, Steketee, Otis and Evans, Inc. July 1975. *Intermediate Level Waste Management Facilities Title I Report (Books 1 and 2)*. Holifield National Laboratory, Oak Ridge, Tennessee. Oak Ridge National Laboratory.

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Samborn, Steketee, Otis, and Evans, Inc. July 1975. *Intermediate Level Waste Management Facilities Design Calculations (Sheets 1 To 69) Tanks W21 Through W31*. Oak Ridge National Laboratory.

Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis*. Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL*. Oak Ridge National Laboratory. ORNL/TM-11652.

FIGURE 2.8-1
Location Of Melton Valley Storage Tank Facility At ORNL

REV. 0 10-11-91

FIGURE 2.8-2
Layout Of The Melton Valley Storage Tanks

REV. 0 10-11-91

FIGURE 2.8-3
Schematic Of The Liquid Low-Level Waste System

REV. 0 10-11-91

FIGURE 2.8-4
General Characteristics Of Waste Samples

Liquid samples:				Sludge samples	
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-28	0.480	No	1/2 ft sludge to the bottom; took second sample for more material	1.2	Field (weight of handle carried sampler to the bottom of the tank) Sludge (W28-S1): deep yellow; seems homogeneous Sunk into sludge; very finely divided with a few dark flakes
W-29	0.110	NA	NA	NA	
W-30	0.110	NA	NA	NA	

FIGURE 2.8-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

TANK	
Characteristic	JAN. 1990
<u>Physical properties and identification data</u>	
TDS (mg/L)	485
TS (mg/L)	478
Density (g/mL)	1.2852
IC (mg/L)	7.8
TC (mg/L)	381
TOC (mg/L)	374
<u>ECRA metals</u>	
Ag (mg/L)	<0.05
As (mg/L)	<1.7
Ba (mg/L)	1.8
Cd (mg/L)	0.31
Cr (mg/L)	0.38
Hg (mg/L)	0.14
Ni (mg/L)	1.4
Pb (mg/L)	<2.2
Se (mg/L)	<4.7
Ti (mg/L)	<1.4
<u>Trace metals</u>	
Al (mg/L)	5.2
B (mg/L)	8.25
Ca (mg/L)	2008
Co (mg/L)	<0.37
Fe (mg/L)	<1.6
K (mg/L)	24000
Mg (mg/L)	1680
Na (mg/L)	34000
Si (mg/L)	<1.8
Sr (mg/L)	45
Tb (mg/L)	<2.2
U (mg/L)	<0.1
<u>Anions</u>	
Chloride (M)	8.14
Fluoride (M)	<0.026
Nitrate (M)	3.97
Phosphate (M)	<0.053
Sulfate (M)	<0.052
<u>Alkalinity</u>	
pH	9.1
H ⁺ (M)	<0.01
OH ⁻ (M)	<0.01
CO ₃ ²⁻ (M)	<0.01
HCO ₃ ⁻ (M)	<0.01
<u>Radioactive content</u>	
Gross alpha (Bq/mL)	4.88e+01
Gross beta (Bq/mL)	9.88e+05
IC (Bq/mL)	1.67e+02
²³⁵ U (Bq/mL)	<1.8e+03
²³⁸ U (Bq/mL)	8.72e+03
²³² Th (Bq/mL)	1.06e+04
²³⁵ Pa (Bq/mL)	1.66e+05
²³⁸ Pa (Bq/mL)	1.67e+03
²³² Pa (Bq/mL)	7.37e+02
²³² Th (Bq/mL)	<9.3e+02
²³² U (Bq/mL)	1.19e+02
²³⁵ U (Bq/mL)	<1.3e+02
²³⁸ U (Bq/mL)	2.07e+03
²³² Th (Bq/mL)	1.71e+05
²³² U (Bq/mL)	<2.2e+02

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

TANK	
Characteristic	JAN. 1990
<u>Physical properties and identification data</u>	
TS (mg/g)	570
Density (g/mL)	1.49
IC (mg/g)	3630
TC (mg/g)	4130
TOC (mg/g)	2500
<u>ECRA metals</u>	
Ag (mg/g)	(12)
As (mg/g)	27
Ba (mg/g)	39
Cd (mg/g)	34
Cr (mg/g)	35
Hg (mg/g)	12
Ni (mg/g)	62
Pb (mg/g)	190
Se (mg/g)	<29
Ti (mg/g)	<9
<u>Trace metals</u>	
Al (mg/g)	830
B (mg/g)	4.9
Ca (mg/g)	57000
Co (mg/g)	<0.8
Fe (mg/g)	620
K (mg/g)	11800
Mg (mg/g)	15000
Na (mg/g)	64000
Sr (mg/g)	130
Tb (mg/g)	1370
U (mg/g)	17800
<u>Radioactive content</u>	
Gross alpha (Bq/g)	5.30e+04
Gross beta (Bq/g)	2.40e+06
IC (Bq/g)	7.60e+01
²³⁵ U (Bq/g)	<1.7e+04
²³⁸ U (Bq/g)	7.31e+04
²³² Th (Bq/g)	<4.6e+03
²³⁵ Pa (Bq/g)	1.94e+05
²³⁸ Pa (Bq/g)	7.18e+05
²³² Pa (Bq/g)	3.28e+05
²³² Th (Bq/g)	9.78e+04
²³² U (Bq/g)	<2.9e+03
²³⁵ U (Bq/g)	<2.8e+04
²³⁸ U (Bq/g)	5.57e+05
²³² Th (Bq/g)	<1.4e+04
<u>Alpha content</u>	
²³⁵ U (Bq/g)	1.46e+01
²³⁸ U (Bq/g)	2.56e+05
²³² Th (Bq/g)	<1.3e+04
²³⁵ Pa (Bq/g)	1.51e+05
²³⁸ Pa (Bq/g)	2.28e+05
²³² Pa (Bq/g)	<1.4e+04
²³² Th (Bq/g)	3.83e+04

LEGEND: PHYSICAL PROPERTIES
 TDS - TOTAL DISSOLVED SOLIDS
 TS - TOTAL SOLIDS
 IC - INORGANIC CARBON
 TC - TOTAL CARBON
 TOC - TOTAL ORGANIC CARBON

REV. 0 10-11-91

Figure 2.8-6
Tank Vault Stainless Steel Liner

REF. DWG.
S-21247-YB.008-e
REV. B

REV. 1 07-20-92

ERASCO/MAIN

Figure 2.8-7 Tank Vault Concrete Details

REV. 1 07-20-92

ERASCO/MAIN

Figure 2.8-8 Tank Vault Grading Plan

2.8-20

REV. 1 07-20-92

EBASCO/MAN

Figure 2.8-9 Tanks W-24 Through W-27 H & V Diagram

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EBASCO/MAIN

2.9 Tank W29, Melton Valley Storage Tank

2.9.1 Tank Summary

Tank W29 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank Facility (Building 7830) (see Figures 2.9-1 and 2.9-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W29 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.9.2 Standards for Design Demonstration

2.9.2.1 Tank Description and Design Standards

Tank Description

Tank W29 is located at the Melton Valley Storage Tank (MVST) Facility in an underground vault with Tanks W28, W30, and W31, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W29 center lines are N 16584.25 and E 28056.5. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W29 is a 50,000-gal, horizontal, tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W29 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications - Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.9.2.2 Generic Description of Tank Contents

Tank W29 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W29 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W29 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W31 for storage (see Figure 2.9-3).

The liquid waste supernate in Tank W29 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W29 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce a radiation level of approximately 1.2 rem per hour (R/h) (see Figure 2.9-4).

The analytical data (see Figure 2.9-5) of waste samples are representative of the waste received by Tank W29; however, the composition of the waste stored in Tank W29 may vary depending upon the experiments conducted by the waste generators.

2.9.2.3 Corrosion Protection Measures

Tank W29 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.9.2.4 Documented Age

Tank W29 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.9.3 Standards for Containment/Release Detection

2.9.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W29 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.9-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.9.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W29 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.9.7). Tank W29 shares the vault structure with Tanks W28, W30, and W31 and is one of eight tanks (W24 through W31) that are located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.9.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W29 is located in a 304L SS-lined vault. Any leakage from Tank W29 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.9.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W29 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W29 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top preventing accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.9.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W29 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W29 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,915 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W29 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W29 provides for surface water runoff to prevent any build-up of surface water during rainfall events. Site grades around the vault containing Tank W29 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.9-8). Finished grades around the vault containing Tank W29 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W29 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of water in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W29 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film, known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W29 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.9-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W29 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W29 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W28, W29, W30, and W31. The fresh air is drawn through Tank W29 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W29 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W29 vault is a 1400 CFM fresh air ventilation system for the Tanks W28, W29, W30, and W31 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.9.4 Supplemental Information

2.9.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W29 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively and is appropriate for this application.

2.9.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.9.4.3 Ancillary Equipment

Single wall piping associated with Tank W29 is located within the confines of the vault system including the pipe and pump room vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS which is the same material as Tank W29 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W29; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W29 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.9.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W29.

2.9.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.9.6 References

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- Coobs, J.H. and J. R. Gissel. 1986. *History of Disposal of Radioactive Waste into the Ground at Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10269.
- Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E
- Energy Systems Drawing - Waste Storage Tanks, Plan Stainless Steel Liner, Tank Vault, S-21247-YB-008-E, Rev. B
- Energy Systems Drawing - Waste Storage Tanks, Sections and Details of Concrete Vault, S-21247-YB-003-E, Rev. D
- Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G
- Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F
- Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
- Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G
- Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G
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- Peretz, F.J., B. R. Clark, C. B. Scott, and J. B. Berry. 1986. *Characterization of Low Level Liquid Wastes at the Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10218.
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Samborn, Steketee, Otis, and Evans, Inc. July 1975. *Intermediate Level Waste Management Facilities Design Calculations (Sheets 1 To 69) Tanks W21 Through W31.* Oak Ridge National Laboratory.

Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis.* Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

MAIN BETHEL VALLEY COMPLEX

EBASCO/MAIN

FIGURE 2.9-2
Layout Of The Melton Valley Storage Tanks

Layout of the Melton Valley Storage Tanks.

REV. 0 10-11-91

FIGURE 2.9-3
Schematic Of The Liquid Low-Level Waste System

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FIGURE 2.9-4
General Characteristics Of Waste Samples

Liquid samples:			Sludge samples:		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-28	0.480	No	.1/soft sludge	1.2	Fluid (weight of to the bottom handle carried took second sampler to the sample for more bottom of the material (tank) Sludge (W-28-S1): deep yellow; seems homogeneous Scolicated sludge: very finely divided with a few dark flakes
W-29	0.110	NA	NA	NA	No sludge sample data for tanks W-29 and W-30 is available; however, the contents of tanks W-29 and W-30 should be very similar to the contents of the tank W-28.
W-30	0.110	NA	NA	NA	

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Figure 2.9-5
Analytical Data For Liquid Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristic	JAN. 1990	W29-L1	W29-L2	W29-L4
Physical properties and substances data				
TDS (mg/L)		375	376	375
TS (mg/L)		377	379	382
Density (g/mL)		1.221	1.227	1.2254
IC (mg/L)		478	477	484
TC (mg/L)		983	1048	853
TOC (mg/L)		347	343	377
RCRA metals				
Ag (mg/L)		<0.09	<0.09	<0.09
As (mg/L)		<3.7	<3.7	<3.7
Ba (mg/L)		1.8	1.1	1.8
Cd (mg/L)		<0.12	<0.12	<0.12
Cr (mg/L)		2.4	2.4	2.3
Hg (mg/L)		0.09	0.08	0.09
Mn (mg/L)		<0.38	<0.38	<0.38
Pb (mg/L)		<2.1	<2.1	2.3
Se (mg/L)		<4.7	<4.7	<4.7
Tl (mg/L)		<1.4	<1.4	<1.4
Trace metals				
Al (mg/L)		18	18	17
B (mg/L)		0.39	0.47	0.34
Ca (mg/L)		4.1	3.5	3.6
Fe (mg/L)		<2.6	<2.6	<2.6
K (mg/L)		10000	10000	10000
Mg (mg/L)		<1.3	<1.3	<1.3
Na (mg/L)		110000	110000	110000
Si (mg/L)		<1.0	<1.0	<1.0
Sr (mg/L)		1.9	2.1	1.9
Th (mg/L)		<1.0	<1.0	<1.0
U (mg/L)		4.3	4.3	4.3
Anions				
Chloride (M)		0.002	0.002	0.002
Fluoride (M)		<0.036	<0.036	<0.036
Nitrate (M)		4.32	4.93	4.31
Phosphate (M)		<0.053	<0.053	<0.053
Sulfate (M)		<0.053	<0.053	<0.052
Acidity				
pH		13.0	13.0	13.0
OH ⁻ (M)		0.064	0.060	0.074
CO ₃ ²⁻ (M)		0.043	0.040	0.034
HCO ₃ ⁻ (M)		<0.01	<0.01	<0.01
Radioisotope analysis				
Conc. alpha (Bq/mL)		<1.0e+01	<1.0e+01	<1.0e+01
Conc. beta (Bq/mL)		2.11e+03	1.90e+03	2.80e+03
¹⁴ C (Bq/mL)		1.42e+02	1.3e+01	2.6e+01
¹⁴⁴ Ce (Bq/mL)		<1.4e+03	<1.3e+03	<1.3e+03
¹³⁷ Cs (Bq/mL)		4.44e+03	3.99e+02	6.26e+02
¹³⁴ Cs (Bq/mL)		2.31e+03	2.77e+03	2.53e+03
¹³⁵ Cs (Bq/mL)		2.31e+03	2.22e+03	2.16e+03
¹³⁷ Eu (Bq/mL)		<1.4e+02	<1.0e+02	<1.3e+02
¹⁵² Eu (Bq/mL)		<1.3e+02	<1.0e+02	<1.3e+02
¹⁵⁴ Eu (Bq/mL)		<7.3e+02	<7.1e+02	<7.3e+02
²³⁸ U (Bq/mL)		2.01e+02	2.01e+02	2.01e+02
²³⁵ U (Bq/mL)		<6.4e+01	<6.2e+01	<6.3e+02
²³⁸ Pu (Bq/mL)		<2.3e+03	<2.0e+03	<2.0e+03
²³⁹ Pu (Bq/mL)		7.23e+03	7.00e+03	3.31e+03
²⁴¹ Pu (Bq/mL)		<9.3e+01	<1.1e+02	<1.0e+02

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.9-6
Tank Vault Stainless Steel Liner

PLAN VIEW

REF. DWG.
S-21247-YB.008-F
REV. B

REV. 1 07-20-92

Figure 2.9-7 Tank Vault Concrete Details

REP DWG.
5-01247-YB-003-E
REV D

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Figure 2.9-8 Tank Vault Grading Plan

2.9-20

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Figure 2.9-9 Tanks W-28 Through W-31 H & V Diagram

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2.10 Tank W30, Melton Valley Storage Tank

2.10.1 Tank Summary

Tank W30 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank (MVST) Facility (Building 7830) (see Figures 2.10-1 and 2.10-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W30 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.10.2 Standards for Design Demonstration

2.10.2.1 Tank Description and Design Standards

Tank Description

Tank W30 is located at the MVST Facility in an underground vault with Tanks W28, W29, and W31, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W30 center lines are N 16584.25 and E 28072.5. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W30 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W30 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

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National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

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UCC-ND Engineering Technical Specifications

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ANSI

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Tank W30 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W30 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W30 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tank W24 through W31 for storage (see Figure 2.10-3).

The liquid waste supernate in Tank W30 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W30 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce a radiation level of approximately 1.2 rem per hour (R/h) (see Figure 2.10-4).

The analytical data (see Figure 2.10-5) of waste samples are representative of the waste received by Tank W30; however, the composition of the waste stored in Tank W30 may vary depending upon the experiments conducted by the waste generators.

2.10.2.3 Corrosion Protection Measures

Tank W30 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.10.2.4 Documented Age

Tank W30 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.10.3 Standards for Containment/Release Detection

2.10.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W30 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.10-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.10.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W30 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.10.7). Tank W30 shares the vault structure with Tanks W28, W29, and W31 and is one of eight tanks (W24 through W31) that are located in vaults at building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.10.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W30 is located in a 304L SS-lined vault. Any leakage from Tank W30 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.10.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W30 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W30 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top preventing accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.10.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W30 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W30 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W30 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W30 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W30 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.10-8). Finished grades around the vault containing Tank W30 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of ground water into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W30 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of water in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W30 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W30 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.10-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W30 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W30 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W28, W29, W30, and W31. The fresh air is drawn through Tank W30 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W30 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W30 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W30 vault is a 1400 CFM fresh air ventilation system for the Tanks W28, W29, W30, and W31 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.10.4 Supplemental Information

2.10.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W30 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively, and is appropriate for this application.

2.10.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA Program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)

ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.10.4.3 Ancillary Equipment

Single wall piping associated with Tank W30 is located within the confines of the vault system including the pipe and pump vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment such as pumps, jet ejectors, valving, and pipe supports are fabricated from 304L SS which is the same material as Tank W30 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W30; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W30 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.10.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W30.

2.10.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

2.10.6 References

Binford, F.T. and S. D. ORFI. 1979. *The Intermediate Level Liquid Waste System at the Oak Ridge National Laboratory Description and Safety Analysis*. Oak Ridge National Laboratory. ORNL/TM-6959.

Coobs, J.H. and J. R. Gissel. 1986. *History of Disposal of Radioactive Waste into the Ground at Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10269.

Energy Systems Drawing - Waste Storage Tanks, Site and Grading Plan, C-21247-YA-002-E, Rev. E

Energy Systems Drawing - Waste Storage Tanks, Plan Stainless Steel Liner, Tank Vault, S-21247-YB-008-E, Rev. B

Energy Systems Drawing - Waste Storage Tanks, Sections and Details of Concrete Vault, S-21247-YB-003-E, Rev. D

Energy Systems Drawing - Waste Storage Tanks, Piping Flow Diagram - Process Sheet No. 1, P-21247-YE-026-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Instrument Flow Diagram - Process, I-21247-YE-002-E, Rev. F

Energy Systems Drawing - Waste Storage Tanks, H&V Flow Diagram, H-21247-YG-001-E, Rev. E
Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Sections, Sheet No. 2, H-21247-YG-004-E, Rev. G

Energy Systems Drawing - Waste Storage Tanks, Tank and Vault Ductwork Plans, H-21247-YG-002-E, Rev. G

Oak Ridge National Laboratory. 1991. *Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory*. Department of Waste Minimization Planning and Certification. WM-WMCO-201.

Peretz, F.J., B. R. Clark, C. B. Scott, and J. B. Berry. 1986. *Characterization of Low Level Liquid Wastes at the Oak Ridge National Laboratory*. Oak Ridge National Laboratory. ORNL/TM-10218.

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Samborn, Steketee, Otis, and Evans, Inc. July 1975. *Intermediate Level Waste Management Facilities Design Calculations (Sheets 1 To 69) Tanks W21 Through W31.* Oak Ridge National Laboratory.

Samborn, Steketee, Otis and Evans, Inc. December 1975. *Special Design Calculations Tank Freezing Analysis, Solvent-Flammability Hazard, Nitrogen Purge, Thermal Pipe Stresses in Vault, Seismic Analysis Tornado Loading Analysis.* Oak Ridge National Laboratory.

Sears M.B. et al. 1990. *Sampling and Analysis of Radioactive Liquid Waste and Sludges in the Melton Valley and Evaporator Facility Storage Tanks at ORNL.* Oak Ridge National Laboratory. ORNL/TM-11652.

FIGURE 2.10-1
Location Of Melton Valley Storage Tank Facility At ORNL

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FIGURE 2.10-2
Layout Of The Melton Valley Storage Tanks

Layout of the Melton Valley Storage Tanks.

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FIGURE 2.10-3
Schematic Of The Liquid Low-Level Waste System

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FIGURE 2.10-4
General Characteristics Of Waste Samples

Liquid samples:			Sludge samples		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-28	0.480	No	.1/soft sludge	1.2	Fluid (weight of to the bottom handle carried took second sampler to the sample for more bottom of the material (tank) Sludge (W-28-S1): deep yellow; seems homogeneous Sonicated sludge: very finely divided with a few dark flakes
W-29	0.110	NA	NA	NA	No sludge sample data for tanks W-29 and W-30 is available; however, the contents of tanks W-29 and W-30 should be very similar to the contents of the tank W-28.
W-30	0.110	NA	NA	NA	

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Figure 2.10-5
Analytical Data For Liquid Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristics:	JAN. 1990	W30-L1	W30-L2	W30-L4
<u>Physical properties and substances, gas</u>				
TDS (mg/L)	371	377	378	
TS (mg/L)	394	391	374	
Density (g/mL)	1.2225	1.2218	1.2211	
IC (mg/L)	402	596	400	
TC (mg/L)	805	695	799	
TOC (mg/L)	283	99	199	
<u>RCRA metals</u>				
Ag (mg/L)	<0.60	<0.60	<0.60	
As (mg/L)	<1.7	<1.7	<1.7	
Ba (mg/L)	0.89	0.84	0.79	
Ca (mg/L)	<0.12	<0.12	<0.12	
Cr (mg/L)	3.8	2.9	2.9	
Hg (mg/L)	0.18	0.18	0.18	
Ni (mg/L)	<0.20	<0.20	<0.20	
Pb (mg/L)	3.8	2.9	2.2	
Se (mg/L)	<4.7	<4.7	<4.7	
Ti (mg/L)	<1.4	<1.4	<1.4	
<u>Toxic metals</u>				
Al (mg/L)	24	23	24	
B (mg/L)	0.49	0.42	0.42	
Cu (mg/L)	18	9.4	11	
Fe (mg/L)	<2.6	<2.6	<2.6	
K (mg/L)	9200	9200	9480	
Mg (mg/L)	<1.3	<1.3	<1.3	
Na (mg/L)	100000	100000	100000	
Si (mg/L)	<1.0	<1.0	<1.0	
Sr (mg/L)	1.7	1.8	1.9	
Ta (mg/L)	<1.8	<1.8	<1.8	
U (mg/L)	5.5	5.8	5.9	
<u>Anions</u>				
Chloride (M)	0.878	0.882	0.878	
Fluoride (M)	<0.034	<0.034	<0.034	
Nitrate (M)	4.35	4.35	4.35	
Phosphate (M)	<0.052	<0.052	<0.052	
Sulfate (M)	<0.052	<0.052	<0.052	
<u>Acidity/alkalinity</u>				
pH	13.3	13.3	13.3	
OH ⁻ (M)	0.13	0.13	0.13	
CO ₃ ²⁻ (M)	0.054	0.052	0.052	
HCO ₃ ⁻ (M)	<0.01	<0.01	<0.01	
<u>Radioisotope analysis</u>				
Gross alpha (Bq/mL)	<1.0e+01	<1.0e+01	<1.0e+01	
Gross beta (Bq/mL)	1.97e+05	1.93e+05	1.92e+05	
¹³⁷ Cs (Bq/mL)	4.8e+01	5.6e+01	1.18e+02	
¹³⁷ Cs (Bq/mL)	<1.3e+03	<1.3e+03	<1.3e+03	
⁶⁰ Co (Bq/mL)	4.92e+02	4.82e+02	4.91e+02	
¹³⁷ Cs (Bq/mL)	2.85e+03	2.82e+03	1.94e+03	
¹³⁷ Cs (Bq/mL)	1.84e+05	1.83e+05	1.90e+05	
¹³⁷ Eu (Bq/mL)	<1.7e+02	<1.7e+02	<1.7e+02	
¹³⁷ Eu (Bq/mL)	<1.3e+02	<1.1e+02	<1.0e+02	
¹³⁷ Eu (Bq/mL)	<4.3e+02	<4.4e+02	<4.4e+02	
¹³⁷ Eu (Bq/mL)	2.01e+02	2.01e+02	2.01e+02	
¹³⁷ Eu (Bq/mL)	<5.3e+01	<5.3e+01	<5.3e+01	
¹³⁷ Eu (Bq/mL)	<1.9e+03	<1.9e+03	<1.9e+03	
¹³⁷ Eu (Bq/mL)	6.73e+03	6.70e+03	6.78e+03	
¹³⁷ Eu (Bq/mL)	<9.5e+01	<1.3e+02	<9.5e+01	

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.10-6
Tank Vault Stainless Steel Liner

PLAN VIEW

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Figure 2.10-7 Tank Vault Concrete Details

Figure 2.10-9 Tanks W-28 Through W-31 H & V Diagram

2.11 Tank W31, Melton Valley Storage Tank

2.11.1 Tank Summary

Tank W31 is a 50,000-gal, horizontal tank located at the Melton Valley Storage Tank (MVST) Facility (Building 7830) (see Figures 2.11-1 and 2.11-2). The tank is constructed of ASME SA-240 type 304L austenitic stainless steel (SS) and is located in an underground, SS-lined, reinforced concrete vault structure. Tank W31 is used as a concentrate storage tank for the LLW Evaporators and is classified as an FFA Category "B" tank.

2.11.2 Standards for Design Demonstration

2.11.2.1 Tank Description and Design Standards

Tank Description

Tank W31 is located at the MVST Facility in an underground vault with Tanks W28, W29, and W30, adjacent to the hydrofracture site in Melton Valley. The ORNL coordinates for Tank W31 center lines are N 16584.25 and E 28088.5. The MVST Facility consists of eight storage tanks numbered W24 through W31.

Tank W31 is a 50,000-gal, horizontal tank constructed of ASME SA-240 type 304L austenitic SS. The tank has an outside diameter of 12' 0" and a horizontal straight sidewall length of 56' 8-7/8" with ASME flanged and dished heads and an overall length of 61' 4-7/8". The shell and the heads have a nominal thickness of 1/2". The tank is designed and stamped as an ASME Section VIII pressure vessel to 15 psig with a design temperature of 150°F and operates at atmospheric pressure or slightly less [-1" water gauge (wg)].

Design Standards

The applicable codes and standards used for Tank W31 and its associated vault and piping are identified herein by engineering discipline. The codes and standards listed are those that were identified on either the design drawings or the construction specifications.

Civil — Site Improvements

ASTM A48, C91, C139, C144, and D1751 of American Society for Testing and Materials (ASTM)

State of Tennessee - Department of Transportation Specifications

Sections 303, 401, 411, 702, and 914.04 of Union Carbide Corporation Nuclear Division (UCC-ND) Standards

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UCC-ND Engineering Standards Y-EF-538

Civil — Excavation, Trenching, and Backfilling

American Association of State Highway Transportation Officials (AASHTO)

American Concrete Institute (ACI) 301-72

American Concrete Pipe Association (ACPA)

Structural — Architectural

ASTM:	A-36	A416	C33	C330
	A-93	A421	C90	C331
	A305	A432	C150	E154
	A307	A611	C205	
	A325	A615-GR60	C270	

ACI 301-72

Concrete Reinforcing Steel Institute (CRSI)

UCC-ND Technical Specialists A-4.3, A-7.1, and A-16.2

UCC-ND Engineering Standards Y-ES-7.15-5

HVAC

Atomic Energy Commission (AEC) General Design Criteria, Appendix 63

Minimum Safety Requirements, AEC-ORO

Occupational Safety and Health Administration

UCC-ND Engineering Standards

UCC-ND Technical Specifications

UCC-ND General Design Criteria, Y-EF-53

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals

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ASHRAE Guide and Data Book - Applications, ASHRAE Guide and Data Book - Equipment, ASHRAE Handbook - Systems

American Conference of Governmental Industrial Hygienists

Air Moving and Conditioning Association (AMCA) Standards Handbook - Publication 99

AMCA Fans and Systems - Publication 201

AMCA Directory - Publication 261

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) High Velocity Duct Construction Standards and Low Velocity Standards

SMACNA Ducted Electric Heat Guide for Air Handling Systems

National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems

NFPA No. 91 - Blower and Exhaust Systems

National Electric Code NFPA No. 70

Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications
- Nuclear Safety Information Center 65

Underwriters' Laboratories, Inc.

Factory Mutual Engineering Corporation

Process/Service System Piping

ASTM

American National Standards Institute (ANSI)

UCC-ND Engineering Standards Specifications

UCC-ND Engineering Technical Specifications

Holifield National Laboratory (HNL) Quality Assurance Manual

HNL Welding Procedure Specifications WPS302

Process Controls

ASTM

Instrument Society of America (ISA)

Scientific Apparatus Manufacturers Association (SAMA)

UCC-ND Engineering Standard

Joint Industrial Council (JIC)

Tanks

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes Sections II, V, VIII, and IX

ASTM A262-70

ANSI

2.11.2.2 Generic Description of Tank Contents

Tank W31 was designed to serve as an interim storage and feed tank for the hydrofracture facility. The waste concentrates stored in Tank W31 were being disposed of as a cement-waste mixture (grout) by injection into shale formations located 800' to 1100' below the ground surface using hydrofracture; however, hydrofracture was terminated in 1984, and Tank W31 has become a waste concentrates storage tank for the liquid low-level waste (LLLW) system. LLLW is generated from a variety of facilities at ORNL, including reactors, radioactive fuel processing areas, radioisotope processing areas, decontamination operations, hot cells, and radiochemical laboratories. The waste generators collect the waste, which is then transferred to the low-level waste evaporator for concentration with transfer of evaporator bottoms to Tanks W24 through W31 for storage (see Figure 2.11-3).

The liquid waste supernate in Tank W31 is single phase and ranges in color from pale to deep yellow with little turbidity and a high pH (11-13) sodium/potassium nitrate salt solutions.

The sludge waste found in the Tank W31 bottom (approximate depth of 44") is light yellow in color with fine to coarse particles. The principal metals found in the tank sludges were sodium, potassium, calcium, magnesium, uranium, and thorium. The sludge contains radioactive materials that produce radiation levels of 1.5 to 2.8 rem per hour (R/h) (see Figure 2.11-4).

The analytical data (see Figure 2.11-5) of waste samples are representative of the waste received by Tank W31; however, the composition of the waste stored in Tank W31 may vary depending upon the experiments conducted by the waste generators.

2.11.2.3 Corrosion Protection Measures

Tank W31 is located in an underground, 304L SS-lined, concrete vault. The tank shell has no direct contact with the soil or water. No cathodic protection measures are required for external corrosion.

The vault is lined with 304L SS (11 gauge bottom with 16 gauge sidewalls) that covers the vault floor and projects 7' 0" up the vault side walls. The vault also has a sloping floor that drains any leaks to a 304L SS-lined sump.

2.11.2.4 Documented Age

Tank W31 came on line in 1980 as an interim storage and feed tank for the hydrofracture facility with the startup of the Intermediate Level Waste Management Facilities Upgrade Project. Therefore, the tank age is 12 years.

2.11.3 Standards for Containment/Release Detection

2.11.3.1 Constructed of or Lined with Materials that are Compatible with Stored Waste

Tank W31 is constructed of ASME SA-240, type 304L SS plate, sheet, and strip. The vault bottom is lined with 11 gauge (1/8") 304L SS with sidewalls of 16 gauge (1/16") 304L SS (see Figure 2.11-6). The selection of vault lining materials is appropriate for the service in which it is used.

2.11.3.2 Placed on Foundation or Base Capable of Providing Support to the Secondary Containment System

Tank W31 is located in an underground, 304L SS-lined, reinforced concrete vault (see Figure 2.11.7). Tank W31 shares the vault structure with Tanks W28 through W30 and is one of eight tanks (W24 through W31) that are located in vaults at Building 7830. The tank vault foundation is a 73' 0" wide by 135' 6" long by 2' 11" thick reinforced concrete base slab that supports Tanks W24 through W31. The tank vault floor elevation is 762' 9" which is 20' 6" below finished grade (EL 783' 3"). The tank vault base slab is set on a limestone rock formation with rock removed (approximately 12' 0") as required for tank vault positioning.

The assessment concludes that the vault foundation supporting the tank secondary containment system is properly designed. Settlement of the containment is insignificant.

2.11.3.3 Provided with a Leak Detection System to Operate to Detect Failure of Either Primary or Secondary Containment Structure or the Presence of any Measurable Release of Hazardous or Radioactive Constituents

Tank W31 is located in a 304L SS-lined vault. Any leakage from Tank W31 flows by gravity to a sump where any accumulation will be detected by a pneumatic level indicator and an alarm sounded in the local Evaporator Service Tanks Control Room and Waste Operations Control Center Building 3130.

2.11.3.4 Sloped or Otherwise Designed or Operated to Drain and Remove Liquids Resulting from Leaks, Spills, or Precipitation

The Tank W31 vault bottom slopes to a 3' 0" long by 3' 0" wide by 1' 0" deep 304L SS-lined sump (67 gal). The sump provides a low point within the tank vault to drain liquids to an instrumented location. A pumping system is provided to remove liquids that accumulate in the sump.

Tank W31 has a nominal total capacity of 50,000 gal with tank inlet and outlet nozzles located on the tank top preventing accidental tank leakage from piping attachment failure. The secondary containment design minimizes rainwater in-leakage; however, the vault maintenance access plugs located on the containment roof are known to leak occasionally. This in-leakage is contained and subsequently removed from the secondary containment system.

The assessment concludes that the secondary containment is sloped and designed to drain and remove liquids resulting from leaks, spills, and precipitation.

2.11.3.5 Secondary Containment for Tank Shall Include One or More of the Following: a Liner, a Vault, a Double Walled Tank or Equivalent Device Approved by the EPA

Tank W31 is located in an SS-lined, reinforced concrete vault. The following addresses specific components of the vault system:

Containment

Tank W31 is located in an underground vault designed to be leaktight. The SS-lined portion of the vault is 67' 6" by 64' 0" by 7' 0" high (from finished vault floor) which represents a total volume of 226,195 gal. Of that total volume, 75,000 gal is occupied by the three other tanks in the vault leaving an available containment volume of 151,195 gal. The nominal full tank content of Tank W31 is 50,000 gal.

The assessment concludes that the SS-lined portion of the vault provides sufficient containment for more than 100% of the capacity of largest tank within the vault.

Infiltration

Site and storm drainage design around the perimeter of the vault containing Tank W31 provides for surface water runoff to prevent any buildup of surface water during rainfall events. Site grades around the vault containing Tank W31 slope away from the tank vault conveying rainwater to storm drain catch basin inlets (see Figure 2.11-8). Finished grades around the vault containing Tank W31 are maintained at a minimum of 6" below perimeter walls to prevent water runoff. The 2' 11" reinforced concrete tank vault walls have an external vapor barrier membrane with an asphalt composition of oxidized asphalt and mineral aggregate forming a waterproofing system. The use of a waterproofing system minimizes infiltration of groundwater into the vault structure. The tank vault finished floor elevation is 762' 9" which is 20' 6" below finished grade. The maximum water table elevation at Tank W31 vault is 770.00' per groundwater measurements.

The tank vault is designed with a 6" polyvinyl chloride (PVC) pipe located around the foundation base to provide a foundation drain system. The PVC pipe header is routed to the watershed.

The minimization of water in-leakage to the secondary containment system is accomplished by a complete 3' 0" thick reinforced concrete slab covering the vault. A maintenance access plug is sealed in place to minimize in-leakage to the vault structure.

Water Stops

Tank W31 secondary containment structure is constructed with chemical resistant PVC water stops and 1-1/2" x 4" keyways in all below grade construction joints.

Coatings/Linings

The interior surfaces of the concrete vault are provided with coatings and linings that are compatible with the stored waste and designed to prevent migration of liquids into the concrete. The continuous welded 304L SS liner is designed as a leaktight barrier to contain more than 100% of the tank volume. The vault surfaces not within the lined areas are provided with an epoxy coating designed to prevent the migration of waste into the concrete.

Corrosion

The vault is a buried reinforced concrete structure lined with 304L SS plate that covers the vault floor and projects 7' 0" up the vault side walls. The backfill material around the reinforced concrete vault is not known. It is important to note that when steel, such as the reinforcing bars of the concrete vault walls, is embedded in concrete, a protective film, known as a "passivating film," develops on the surface. This film, which consists of gamma ferric oxide, is formed by cement hydration and is maintained in the alkaline environment of the concrete. The passivating film acts like a protective coating that precludes corrosion from taking place on the steel as long as the film is maintained intact.

Vapor Protection, Vessel Vent System

Tank W31 is provided with a tank offgas system (primary system) and a vault space ventilation system (secondary system) (see Figure 2.11-9).

Explosive mixtures are not used in the operation of the LLLW facilities; however, flammable mixtures such as solvents and gases could be used in small quantities. Tank W31 is provided with a provision for tank purging with an inert gas in the event some laboratory operation accidentally releases a flammable solvent into the waste system.

The primary ventilation system for Tank W31 is a 400 CFM fresh air system that provides 100 CFM of parallel flow to Tanks W28, W29, W30, and W31. The fresh air is drawn through Tank W31 by a 400 CFM tank offgas exhaust fan and passes through a roughing filter, pre-filter, and high efficiency particulate air (HEPA) filter before entering the tank. The air passes through Tank W31 and is discharged to the atmosphere through a demister, a roughing filter, and two HEPA filters. The primary ventilation system for Tank W31 is designed with an operating pressure of 0.5" to 1" of wg negative pressure.

The ventilation system for the Tank W31 vault is a 1400 CFM fresh air ventilation system for the Tanks W28, W29, W30, and W31 containment vault. The fresh air is drawn through a roughing filter and pre-filter by a 1400 CFM secondary containment exhaust fan and is swept through the cell and then discharged to the atmosphere through a flame arrestor, a roughing filter, and a HEPA filter.

The secondary ventilation system is designed with an operating pressure of 0.5" to 1" of wg negative pressure. The primary and secondary ventilation system exhaust duct, fans, and stacks are located on top of the vault roof slab with the top of stack elevation at 15' 0" above grade.

2.11.4 Supplemental Information

2.11.4.1 Earthquakes

The below grade, SS-lined, reinforced concrete vault (secondary containment) for Tank W31 is designed to withstand earthquake loads as specified in the Uniform Building Code for Seismic Zone 2 which includes the Oak Ridge Reservation. The vault is designed to withstand a design earthquake with horizontal and vertical accelerations of 0.15 and 0.10 g, respectively, and is appropriate for this application.

2.11.4.2 Quality Assurance

A Quality Assurance (QA) Program was established for the Intermediate Level Waste Management Facilities which include the Evaporator Services Tanks W21 through W23 and the MVST Facility Tanks W24 through W31.

The QA program provides guidance for applying QA practices to improve the reliability of systems and components for operational reliability.

QA Programs

ILW Quality Assurance Program Plan for Design Doc. No. 289 (12-1-76)
ILW Quality Assurance Program Plan QAPP-EP-2 (3-8-75)

Design

The QA Program for design development includes planning, definition and control of design, design reviews, document review and control, and audit of design activities.

Procurement

The QA Program for procurement includes planning, selection and evaluation of procurement sources, preparation and review of procurement documents, source and receiving inspection activities, control of finished items, and audit of procurement activities.

Construction and Installation

The QA Program for construction includes inspection of construction and installation activities, witnessing preoperational and startup testing of equipment and systems, compilation and maintenance of QA records and data generated to verify satisfaction of specific requirements, and prompt resolution of quality related problems.

2.11.4.3 Ancillary Equipment

Single wall piping associated with Tank W31 is located within the confines of the vault system including pipe and pump vault with any leaking fluid captured in SS-lined sumps and pumped to the MVST Facility Tanks W24 through W31. Piping and related equipment (such as pumps, jet ejectors, valving, and pipe supports) are fabricated from 304L SS, which is the same material as Tank W31 and the vault liner. The transfer piping and associated equipment are exposed to the same liquids as Tank W31; therefore, 304L SS is acceptable for the support equipment. LLLW piping servicing Tank W31 located outside of the vault structure is double walled piping with a pressurized annulus and cathodic protection. The pipe is located underground with a minimum of 36" of earth cover. The secondary containment (jacket) of the piping system provides capture, detection, and removal of leaks from the primary carrier without endangering the environment.

The assessment concludes that the ancillary equipment is properly designed for leak detection and secondary containment.

2.11.4.4 Waste Acceptance Criteria

Radioactively contaminated liquid wastes at ORNL are generated by various activities within the research and operating divisions. These activities include radiochemical processing, routine hot cell operations and decontamination, and various waste treatment and environmental protection processes. The variations in composition of the waste streams are limited by the waste acceptance criteria that specify activity and concentration limits for waste discharged into the LLLW system. *The Waste Acceptance Criteria for Liquid Waste Treatment Systems at the Oak Ridge National Laboratory* dated July 1991 is a guide for liquid waste generators to determine the proper means of disposal for routine wastewater streams. The criteria show future discharge guidelines for the LLLW system which includes Tank W31.

2.11.5 Conclusions

The assessment concludes that the secondary containment system meets applicable requirements contained in the FFA Appendix F, Subsection C entitled "Standards for Containment/Release Detection."

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DESIGN DEMONSTRATIONS - CATEGORY B LLLW TANK SYSTEMS

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FIGURE 2.11-1
Location Of Melton Valley Storage Tank Facility At ORNL

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FIGURE 2.11-2
Layout Of The Melton Valley Storage Tanks

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FIGURE 2.11-3
Schematic Of The Liquid Low-Level Waste System

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**FIGURE 2.11-4
General Characteristics Of Waste Samples**

Liquid samples:			Sludge samples		
Tank	Radiation level (R/h)	Organic layer	Number/type	Radiation level (R/h)	Comments
W-31	0.180	No	2/soft sludge	1.5-2.2	Soakated soft sludge; medium tan, watery sludge; fine and very fine particles separated during centrifugation
			1/hard sludge	2.8	Hard sludge; appearance of clay or mud with a little grit

2.11-16

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FIGURE 2.11-5
Analytical Data For Liquid And Sludge Samples

**ANALYTICAL DATA FOR
LIQUID SAMPLE**

Characteristic	JAN. 1990	W31-L2
<u>Physical properties and miscellaneous data</u>		
TDS (mg/L)		351
TS (mg/L)		349
Density (g/mL)		1.0075
IC (mg/L)		18.9
TC (mg/L)		464
TOC (mg/L)		445
<u>ECRA metals</u>		
Ag (mg/L)		<0.05
As (mg/L)		<3.7
Ba (mg/L)		3.5
Cd (mg/L)		<0.11
Cr (mg/L)		6.0
Hg (mg/L)		0.11
Ni (mg/L)		<0.38
Pb (mg/L)		<2.1
Se (mg/L)		<1.7
Ti (mg/L)		<1.1
<u>Trace metals</u>		
Al (mg/L)		4.2
B (mg/L)		0.20
Ca (mg/L)		79
Ce (mg/L)		<0.57
Co (mg/L)		<2.4
Fe (mg/L)		9500
K (mg/L)		<1.3
Mg (mg/L)		94000
Na (mg/L)		8.51
Si (mg/L)		12
Sr (mg/L)		<2.2
Th (mg/L)		0.15
U (mg/L)		
<u>Anions</u>		
Chloride (M)		0.072
Fluoride (M)		<0.026
Nitrate (M)		4.52
Phosphate (M)		<0.053
Sulfate (M)		<0.053
<u>Acidity</u>		
pH		11.7
H ⁺ (M)		0.01
OH ⁻ (M)		<0.01
CO ₃ ²⁻ (M)		<0.01
HCO ₃ ⁻ (M)		
<u>Radioactive isotopes</u>		
Gross alpha (Bq/L)		<1.8e+00
Gross beta (Bq/L)		3.36e+01
¹³⁷ Cs (Bq/L)		1.12e+02
¹³⁴ Cs (Bq/L)		<7.8e+02
¹³⁷ Co (Bq/L)		2.23e+02
¹³⁷ Eu (Bq/L)		5.01e+03
¹³⁷ Gd (Bq/L)		2.29e+05
¹³⁷ La (Bq/L)		<9.3e+01
¹³⁷ Pr (Bq/L)		<6.7e+01
¹³⁷ Sm (Bq/L)		<4.2e+02
¹³⁷ Th (Bq/L)		1.58e+02
¹³⁷ U (Bq/L)		<3.3e+01
¹³⁷ Am (Bq/L)		<1.1e+03
¹³⁷ Pa (Bq/L)		7.38e+01
¹³⁷ Zr (Bq/L)		<5.7e+01

**ANALYTICAL DATA FOR
SLUDGE SAMPLE**

Characteristic	JAN. 1990	W31-G
<u>Physical properties and miscellaneous data</u>		
TS (mg/L)		369
Density (g/mL)		1.26
IC (mg/L)		1410
TC (mg/L)		1820
TOC (mg/L)		410
<u>ECRA metals</u>		
Ag (mg/L)		<0.1
As (mg/L)		<33
Ba (mg/L)		17
Cd (mg/L)		1.7
Cr (mg/L)		27
Hg (mg/L)		14
Ni (mg/L)		17
Pb (mg/L)		170
Se (mg/L)		<41
Ti (mg/L)		<13
<u>Trace metals</u>		
Al (mg/L)		1400
B (mg/L)		<1.3
Ca (mg/L)		5600
Ce (mg/L)		<1.1
Co (mg/L)		420
K (mg/L)		7900
Mg (mg/L)		870
Na (mg/L)		69000
Si (mg/L)		30
Th (mg/L)		2790
U (mg/L)		3800
<u>Radioactive isotopes</u>		
Gross alpha (Bq/L)		2.31e+00
Gross beta (Bq/L)		3.18e+00
¹³⁷ Cs (Bq/L)		3.14e+02
¹³⁴ Cs (Bq/L)		<9.4e+03
¹³⁷ Co (Bq/L)		8.18e+03
¹³⁷ Eu (Bq/L)		2.64e+05
¹³⁷ Gd (Bq/L)		2.25e+05
¹³⁷ La (Bq/L)		<1.7e+04
¹³⁷ Pr (Bq/L)		5.86e+03
¹³⁷ Sm (Bq/L)		<5.9e+03
¹³⁷ Th (Bq/L)		<9.2e+02
¹³⁷ U (Bq/L)		<1.4e+04
¹³⁷ Am (Bq/L)		1.42e+05
¹³⁷ Pa (Bq/L)		<4.7e+03
<u>Alpha emitters</u>		
²³⁸ U (Bq/L)		1.08e+02
²³⁵ U (Bq/L)		<3.7e+03
²³² Th (Bq/L)		8.79e+02
²³⁸ Pa (Bq/L)		2.43e+03
²³⁸ Am (Bq/L)		<8.4e+03
²³⁸ Ca (Bq/L)		1.71e+04

LEGEND: PHYSICAL PROPERTIES
TDS - TOTAL DISSOLVED SOLIDS
TS - TOTAL SOLIDS
IC - INORGANIC CARBON
TC - TOTAL CARBON
TOC - TOTAL ORGANIC CARBON

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Figure 2.11-6
Tank Vault Stainless Steel Liner

PLAN VIEW

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Figure 2.11-7 Tank Vault Concrete Details

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Figure 2.11-9 Tanks W-28 Through W-31 H & V Diagram

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