**Detailed Leak Detection Test Plan and Schedule for
Oak Ridge National Laboratory Liquid Low-Level
Waste Active Tanks**

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Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

**Detailed Leak Detection Test Plan and Schedule for Oak Ridge
National Laboratory Liquid Low-Level Waste Active Tanks**

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Executive Summary

This document provides a detailed leak detection test plan and schedule for leak testing many of the tanks that comprise the active portion of the liquid low-level waste (LLLW) system at the Oak Ridge National Laboratory (ORNL). This plan was prepared in response to the requirements of the Federal Facility Agreement (FFA) between the U.S. Department of Energy (DOE) and two other agencies, the U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC).

The LLLW system is an interconnected complex of tanks and pipelines. The FFA distinguishes four categories of tank and pipeline systems within this complex: new systems (Category A), doubly contained systems (Category B), singly contained systems (Category C), and inactive systems (Category D). The FFA specifically requires leak testing of the Category C systems; there are 14 such tanks addressed in this plan, together with a schedule for testing these tanks. The plan and schedule also addresses leak testing of one tank (W-12) which EPA, TDEC, and DOE have agreed to temporarily return to service to support decontamination activities in Building 3525. The plan addresses an additional 15 Category B tanks that have been shown to meet the requirements for secondary containment. These 15 tanks are addressed here for the sake of completeness, but have been removed from the leak testing program due to approval of the design demonstrations that show secondary containment. This document, therefore, describes the plans for testing 15 of the LLLW tanks in the system; plans for testing the pipelines will be described in a separate document.

The approach that has been taken in preparing this plan, and that will be taken in executing it, is fully responsive to the requirements of the FFA. A key feature of the plan is that it is based on the use of *performance standards* for the conduct of release detection testing and on the use of methods whose performance has been evaluated and shown to meet those standards. Another feature of the plan is that it is based in part on relevant portions of current federal EPA regulations applicable to underground tanks and pipelines (UST systems) that store and transfer petroleum products and other hazardous substances. While the FFA does not require that the leak testing at ORNL follow these regulations, the regulations do provide industry- and regulator-accepted performance standards, as well as a schedule for repeated testing of UST components. This plan recognizes, however, that because the operation of the LLLW system at ORNL is very different from the operation of standard UST systems, the EPA's UST regulation cannot be applied to it blindly. This plan therefore makes adjustments in the application of the regulation as demanded by operational considerations.

The LLLW tanks will be leak tested on a monthly schedule; the release detection method to be used has been evaluated and shown to detect a 0.2-gal/h leak with a probability of detection (P_D) not less than 95% and a probability of false alarm (P_{FA}) not more than 5%. Where it is both possible and practical, visual inspections of the various components will be used in lieu of other testing methods. The use of visual inspections will be accompanied by suitable audit trails and quality assurance procedures. The leak testing program will be implemented in accordance with a testing priorities schedule that recognizes the probability of leakage, risks associated with the tank

contents, the various tank configurations and operational considerations, the need to install ancillary instrumentation, and the need to use methods whose performance has been established.

This document serves to formalize the testing protocols to be used, as well as to develop the priorities and the schedule for testing the tanks. This document is a follow-up to a more expansive version of the leak testing plan, which provided the technical basis for the present program, including a detailed discussion of the LLLW system and the performance evaluation of the differential-pressure technique as a leak testing method.

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List of Acronyms

CVR	Compensated volume rate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DP	Differential pressure
FFA	Federal Facility Agreement
LLW	Liquid low-level waste
NHF	New Hydrofracture Facility
ORR	Oak Ridge Reservation
ORNL	Oak Ridge National Laboratory
P_D	Probability of detection
P_{FA}	Probability of false alarm
SARA	Superfund Amendment and Reauthorization Act
TDEC	Tennessee Department of Environment and Conservation
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
UST	Underground storage tank
V/H	Volume-to-height ratio
WOCC	Waste Operations Control Center

1 Introduction

1.1 Purpose and Scope

This document provides a plan and schedule for leak testing a portion of the Liquid Low-Level Waste (LLLW) system at the Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee. It is a concise version of a more general leak testing plan [1] that was prepared in response to the requirements of the Federal Facility Agreement (FFA) for the Oak Ridge Reservation (ORR) [2]. This plan includes a schedule for the initial reporting of the leak test results from the various tanks that will be tested.

The FFA distinguishes four categories of tank and pipeline systems: new systems (Category A), doubly contained systems (Category B), singly contained systems (Category C), and inactive systems (Category D). The FFA specifically requires leak testing of the Category C systems; there are 14 such tanks addressed in this plan, plus one tank (W-12) that has been temporarily returned to service based on EPA and TDEC concurrence. A schedule for testing these tanks is also included. The plan and schedule also addresses an additional 15 Category B tanks have been demonstrated to meet secondary containment requirements. While these 15 tanks are addressed in this plan for the sake of completeness, they have been removed from the leak testing program based on the design demonstrations that show secondary containment. It is noted that the general plan [1] included 42 tanks. Since that report was issued, 26 of those tanks have passed secondary containment design demonstrations [4,5] and subsequently have been removed from this leak testing plan. In addition, one tank (LA-104) has been removed from service. Accordingly, this document addresses 15 of the LLLW tanks in the system; plans for testing the pipelines will be described in a separate document.

The testing program will be implemented in accordance with a schedule of priorities that recognizes the probability of leakage and the risks associated with the tank contents (see Appendix A), the various tank configurations and operational considerations, the need to install ancillary instrumentation, and the need to use methods whose performance has been established.

To facilitate the reader's understanding of the LLLW system and this plan, this document first provides a simple overview of the system. This is followed by a description of the tanks to be tested for leaks and a discussion of some of the characteristics of the tanks. Since these tanks exhibit only modest differences in volume capacity, instrumentation, and other factors, the same test method will be used on all of them. Individual differences between tanks or differences in tank instrumentation will have only a minor impact on the testing procedures. This plan describes the specific protocol to be used with each tank, with particular emphasis on the testing protocol. Because the LLLW system is complex, with a variety of existing computer-measurement capabilities, a test program priority is established so that leak testing can be implemented in an orderly manner consistent with the needs and limitations of the facility.

1.2 Background

The Oak Ridge National Laboratory is located approximately 25 miles west of Knoxville, Tennessee, within the Oak Ridge Reservation. Operations at ORNL began in 1943 as part of the Manhattan Project. Since that time, the laboratory's role has expanded to include nuclear fuel reprocessing research, radioisotope production, and nuclear reactor concepts. More recently, the laboratory has increasingly engaged in multidisciplinary activities that include biological, environmental, energy, and materials research.

Many of the liquid waste materials generated in the course of the work at ORNL are collected by the LLLW system. The system is comprised of 42 separate tanks, with thousands of feet of networked piping connecting the LLLW source locations with the various tanks. The volume capacity of the tanks in the currently active portion of the LLLW system ranges from 40 to 50,000 gal.

The Superfund Amendment and Reauthorization Act (SARA) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that the Department of Energy (DOE) execute a Federal Facility Agreement (FFA) with the Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC) for the Oak Ridge Reservation. The FFA for the ORR establishes new requirements for the tank systems at ORNL, including the preparation and implementation of a leak testing plan for many of the LLLW tanks. The objective of this detailed leak detection test plan and schedule is to summarize the leak testing program at ORNL so that the relevant portions of the system can be brought into compliance with the requirements of the FFA.

2 Overview of the LLLW System

The function of the LLLW system is to safely handle the low-level radioactive liquid waste that is generated in the various research laboratories and operations buildings at ORNL. The LLLW system is a network of tanks, lines, pumps, valve boxes, and valves spanning both the Bethel Valley and Melton Valley complexes of the ORNL. A map that roughly illustrates the geographical extent of the active portion of the LLLW system is shown in Figure 1. The active portion of the system is comprised of both singly and doubly contained tanks and lines.

The operation of the LLLW system entails the movement of low-level aqueous waste products through various pipelines and tanks, from a generator facility to a long-term storage facility. Figure 2 is a schematic diagram of the existing, active LLLW collection, transfer, and waste treatment system in the Bethel and Melton Valleys. This figure shows that there are 7 buildings in Melton Valley and 14 in Bethel Valley that generate low-level liquid wastes. Generally, a generator facility will initially store its waste in local collection tanks. When the waste in these tanks reaches some pre-determined level (typically, 60% to 70% of the volume capacity of the tank), the contents are pumped through underground pipelines to the central waste collection header (located in Bethel Valley), and then to interim service tanks at the evaporator facility where the wastes are concentrated and temporarily stored. There are 9 collection or service tanks in Melton Valley; Bethel Valley has 18 such tanks plus an additional 5 evaporator service tanks, for a total of 23 tanks. When the volume in the concentrate tank reaches a certain level, the contents are pumped to long-term storage near the New Hydrofracture Facility (NHF), shown at the bottom of Figure 1. (The distillate from the evaporator is pumped to the process waste facility; here, any remaining low-level radioactivity is stripped from the distillate and returned to the evaporator facility for reprocessing.) There are 9 tanks in the NHF area. Eight of the tanks in this area are used to store the concentrated waste; one tank (T-13) is a collection tank.

The foregoing reveals that there are 40 ORNL LLLW tanks in active service, and one tank which has been temporarily returned to service based on EPA and TDEC concurrence. Of these, 26 are Category B, 14 are Category C, and one tank is Category D. Table 1 provides an overview of the doubly contained tanks, and Table 2 provides an overview of the singly contained tanks. As described in a DOE report [4,5], 26 of the doubly contained tanks have passed a secondary containment design demonstration. Accordingly, these tanks have been determined to be FFA Category B tanks and have been removed from the leak testing program.

Figure 3 shows a histogram of the distribution of tank volumes for the systems shown in Table 2 that are included in the leak testing program and will be leak tested. The abscissa of this graph shows tank volume, and the ordinate shows the number of tanks with that volume capacity; the "bin size" used for the histogram is 500 gal. This graph shows that the leak testing plan will address two tanks with volume capacities between 0 and 499 gal, one with a capacity between 500 and 999 gal, five that are between 1,000 and 1,499 gal, and so on.

Figure 1. Map showing the distribution of the active portion of LLLW system in the Bethel and Melton Valleys of the ORR .

Figure 2. Diagrammatic representation of the active portion of the LLLW collection, transfer, and waste treatment systems.

Table 1. Top-level Description of Doubly Contained Tanks in the Active Portion of the LLLW System

Tank						Piping		
Designation	Location	Capacity (gal)	Installed	Method of Burial	Material	% in Facilities Doubly Contained	% Underground Doubly Contained	Length of Buried Piping (ft)
C-1	2531 (BV)	50,000	1964	IGV	304L SS	75	96	300 (est)
C-2	2531 (BV)	50,000	1964	IGV	304L SS			
N-71	3019 (BV)	240	1954	AGV	304L SS	100	0	797
P-3	3019 (BV)	197	1954	AGV	347 SS			
P-4	3019 (BV)	197	1954	AGV	347 SS			
S-223	3517 (BV)	3,000	1955	IGV	304L SS	100	98	400
S-324	3517 (BV)	1,000	1955	IGV	304L SS			
S-523	3517 (BV)	1,000	1955	IGV	304L SS			
L-11	3544 (BV)	500	1974	AGV	SS	0	25	1025
B-2-T	7930 (MV)	1,870	1965	IGV	304L SS	60 (est)	0	9350
B-3-T	7930 (MV)	1,870	1965	IGV	304L SS			
C-6-T	7930 (MV)	710	1964	IGV	304L SS			
F-111	7920 (MV)	125	1962	IGV	304L SS			
F-126	7920 (MV)	1,200	1962	IGV	304L SS			
W-21/W-23	2537 (BV)	50,000 (ea)	1979	IGV	SS	100	100	9100 (est)
W-24/W-31	7830 (NHF)	50,000 (ea)	1980	IGV	SS	100	100	6200 (est)
T-13	7860 (NHF)	3,000	1979	IGV	SS	100	100	250 (est)

Legend: BV - Bethel Valley   BT - Buried Tank (backfilled)   SS - Stainless Steel
 MV - Melton Valley   IGV - In-ground vault
 NHF - New Hydrofracture Facility   AGV - Above-ground vault

Table 2. Top-level Description of Singly Contained Tanks in the Active Portion of the LLLW System

Tank						Piping		
Designation	Location	Capacity (gal)	Installed	Method of Burial	Material	% in Facilities Doubly Contained	% Underground Doubly Contained	Length of Buried Piping (ft)
2026A	2026 (BV)	500	1962	IGV	304L SS	0	0	1,276 (est)
WC-3	3025 (BV)	1,100	1951	BT	347 SS	0	0	755
WC-19	3047 (BV)	2,100	1955	BT	347 SS	0	0	1,605
WC-9	3503 (BV)	2,150	1952	BT	347 SS	0	0	1,202
WC-7	3504 (BV)	1,100	1951	BT	347 SS	0	0	849 (est)
HFIR	7910 (MV)	13,000	1961	BT	SS	0	0	2,688
T-1	7587 (MV)	15,000	1963	BT	304L SS			
T-2	7587 (MV)	15,000	1963	BT	304L SS			
WC-10	3587 (BV)	2,300	1951	BT	SS	10	0	2,473
WC-2	3092 (BV)	1,000	1951	BT	347 SS	0	0	1,100 (est)
W-16	STF (BV)	1,000	1951	BT	347 SS	0	0	675
W-12*	3523 (BV)	1,000	1947	BT	SS	0	0	617
F-201	3525 (BV)	40	1962	IGV	304L SS	0	0	367 (est)
F-501	3525 (BV)	200	1962	IGV	304L SS			
LA-104**	3047 (BV)	296	1960	IGV	304 L SS	0	0	100 (est)
WC-20	7567 (MV)	10,000	1976	IGV	304L SS			

Legend: BV - Bethel Valley   BT - Buried Tank (backfilled)
                  MV - Melton Valley   IGV - In-ground vault
                  SS - Stainless Steel   AGV - Above-ground vault

* W-12 has been temporarily returned to active service

** LA-104 has been removed from service and placed in Category D.

Figure 3. Histogram showing distribution of tank volumes for LLLW tanks to be leak tested.

3 Leak Testing Plan

The detailed leak detection test plan and schedule presented here is consistent with the requirements of the FFA [2]. A key element of the plan is that it is technically defensible and achievable. The plan is structured so that it can be implemented within the time frame and budget allocated to it, and it is consistent with the priorities assigned to each segment of the plan. Based upon the findings of the work leading its development [1,4,5,6] the leak testing plan for the LLLW tanks can be summarized in the following points:

- For each component of the LLLW system that will be tested for leaks, a leak detection protocol specific to that component will be used.
- Existing LLLW level-measuring instruments will be used as the basis for the leak detection method; ancillary sensors will be added if they are necessary from a technical perspective.
- The volumetric leak detection methods used to test LLLW system components have been evaluated; therefore, their performance is known and documented.
- The performance records indicate that the volumetric methods used at ORNL will detect a specified leak rate with a probability of detection (P_D) no less than 95% and a probability of false alarm (P_{FA}) no greater than 5%.
- Monthly tests will utilize a leak detection criterion of 0.2 gal/h.
- Each component will be tested on a regular basis; tanks will be tested once per month, to the extent allowed by weather and other factors.
- Tanks will be inspected visually in cases where this is possible and practical.
- The leak testing program for the LLLW tanks will be phased in, consistent with the schedule for installing the necessary test instruments and related equipment, and consistent with the priorities list developed for the LLLW tanks.

3.1 Leak Testing Methods and Detection Criterion

Figure 4 illustrates the leak testing plan for the LLLW tanks. It shows the leak detection methods to be used on tanks, the testing schedule, the leak test criteria, and the type of report generated. As described in the general leak testing plan [1], the LLLW tanks will be tested monthly, using volumetric methods or visual inspection techniques. In the case of volumetric testing, the only methods used will be ones that have been evaluated and that demonstrate sufficient performance to detect leaks of 0.2 gal/h, with a P_D of at least 95%, and a P_{FA} of no more than 5%. The use of such procedures meets existing federal regulations that apply to owners and operators of underground storage tanks containing petroleum or other hazardous materials [6]. For the tanks where visual access is possible, detailed inspection methods and audit trails will be

established. The results from each monthly test will be maintained in a database; this allows long term trends to be established, along with other statistical measures.

Figure 4. Structure of the leak testing plan for the LLLW system.

3.1.1 Leak Detection Method

The primary leak detection method for testing the tanks will be the "DP *method*," which uses a differential-pressure sensor (DP cell) configured as a level sensor (a *bubbler*). This is illustrated in Figure 5. Here, one side of the DP cell is connected to a tube that extends nearly to the bottom of the LLLW tank (the *dip leg*), while the other side is connected to a port in the top of the tank to serve as a pressure *reference*. A small flow of regulated air is maintained through both legs, which results in a thin stream of bubbles being emitted from the dip leg tube (hence the term "bubbler" to describe this sensor). As the liquid level in the tank increases, the pressure required to create the bubbles increases; the DP cell senses this increase in pressure and signals an increased level. As the level decreases, the DP cell senses reduced pressure. Small changes in level are measured as small changes in pressure.

Volume is determined from the level data by combining the latter with the tank chart for each individual tank. The leak detection method temperature-compensates the output of the sensor for its susceptibility to changes in sensor temperature (ambient temperature changes); this step improves the precision of the instrument and allows a quantitative leak test to be accomplished with the precision necessary to achieve the specified release detection

criterion of 0.2 gal/h and within a relatively short period of time (e.g., hours or days instead of days or weeks).

Figure 5. A sketch of the DP method used for leak testing the LLLW tanks.

3.1.2 Test Period and Testing Frequency

Each tank will be tested monthly, as described above. A leak detection test is comprised of two distinct parts, as shown in Figure 6: a *waiting period* and (one or) two *trial periods*. At the beginning of the waiting period, all programmatic inputs, transfers, and all ancillary tank operations such as air- and dip-leg sparging ("blow-down") will be suspended. These operations will not be re-initiated until the leak test has been concluded. The purpose of the waiting period is to allow the tank's contents to "settle down" and come into thermal and mechanical equilibrium with their surroundings. Following the waiting period, the trial period(s) are initiated, during which the tank volume and other sensor data are analyzed to reach a leak test decision.

The leak test algorithm examines the tank volume data over the duration of the first trial period. It checks this and other data for data quality problems and known environmental effects. If the data quality is adequate, a leak test decision can be made from the results of a single trial, as described in Section 3.1.3. If the data are deficient in some way, the algorithm flags that condition and initiates analysis of the data in the second trial period, which leads to a test

decision based upon two trials; this is referred to as a *multiple test strategy*. To achieve the necessary performance, the duration of a trial period is related to the tank volume.

Figure 6. The three parts of a complete test period: waiting period and two trial periods.

3.1.3 Decision Matrix

Depending upon whether one or two trials are needed, a leak test results in one of five decisions: PASS, FAIL, INCONCLUSIVE, INFLOW, or EMPTY. If the result of the first trial is PASS, the test decision is PASS and the test is terminated. If the result of the first trial is FAIL, INFLOW, INCONCLUSIVE, or EMPTY, the data from the second trial period are analyzed. This result is combined with the first result and used to formulate a test decision. Figure 7 is a logic diagram that illustrates how a test decision is made in the case of a PASS, FAIL, or INCONCLUSIVE second test result. If the result of the second trial is PASS, the tank passes the test. If the result of the second trial is INCONCLUSIVE, the test decision is INCONCLUSIVE and a re-test is scheduled for the following weekend. If the result of the second trial is FAIL, the test decision depends upon the difference between the compensated volume rates (CVR) of the two trials: if the difference is small, indicating good data quality over the duration of the test, the test decision is FAIL; if the difference exceeds a quality margin, the test decision is INCONCLUSIVE and a re-test is scheduled. An INFLOW decision is made if the CVR is positive. An EMPTY decision is made if the level in the tank is at or below the bottom of the dip tube.

Two failed trials are required before a tank is deemed to have failed the test. If this happens, a number of important steps are taken to verify the test result. The first is to make an immediate and detailed inspection of the data; data must be of sufficient quality to achieve a reliable test result. The second is to verify that the test was performed according to the prescribed procedures. The third is to verify that instrument calibration or other systematic effects were not factors in the result. If the data quality is good, and if there were no outside factors contributing to the test result, a second test is run. If the tank also fails the second test, appropriate procedures, as described in the FFA, are initiated.

The strategy described above helps to ensure that false alarms are minimized and that at the same time a high probability of detection is maintained.

M_i = Compensated Volume Rate (i^{th} trial)

Figure 7. Decision matrix for multiple trials.

3.2 List of Tanks

Table 3 lists the tanks that will be tested, along with their salient characteristics and the test method and protocols for each. The entries in this table that are related to the tank and its geometry include tank orientation (horizontal or vertical), the dimensions of the tank, the maximum volume capacity of the tank in comparison to its "working" volume (normally, 70% of the maximum), and the calculated volume-to-height ratio (V/H) of the tank. The volume-to-height ratio is tank-specific and describes the change in volume per unit change in liquid depth; this quantity is needed because the sensors used by the leak detection method measure liquid level, and the leak detection protocol requires the tank volume. Table 3 also lists the leak detection method that will be used to test each tank, and the duration of both the waiting period and a single trial period applicable to that method.

Table 3. Summary of Tank Characteristics and Leak Detection Protocols

Tank	Orientation	Diameter*	Length**	Volume (Max/ Nominal)	Volume/ Height** (Gal/In.)	Method	Waiting Period (h)	Trial Duration (h)
2026A	V	4 ft	6 ft 11 in.	/500	7.77	DP	12	24
F-201†	V	1 ft 6 in.	(3 ft 3 in.)	/40	1.08	DP	12	24
F-501	V	4 ft	(4 ft 11.5 in.)	/200	7.77	DP	12	24
HFIR	H	(8 ft)	(35 ft)	13,000/9100	170.26***	mod DP	12	48
T-1	H	10 ft	27 ft 5 in.	15,000/10,500	164.74***	mod DP	12	48
T-2	H	10 ft	27 ft 5 in.	15,000/10,500	164.74***	mod DP	12	48
W-12	V	5 ft 6 in.	6 ft 9.5 in.	1000/700	14.72	DP	12	24
W-16	V	5 ft 6 in.	6 ft 9.5 in.	1000/700	14.72	DP	12	24
WC-2	V	5 ft 6 in.	6 ft 9.5 in.	1000/700	14.72	DP	12	24
WC-3	V	5 ft 6 in.	6 ft 9.5 in.	1000/700	14.72	DP	12	24
WC-7	V	5 ft 4 in.	7 ft 5 in.	1100/750	13.84	DP	12	24
WC-9	V	7 ft	10 ft 9 in.	2150/1500	23.88	DP	12	24
WC-10	H	6 ft 4 in.	10 ft 4 in.	2300/1650	38.11***	DP	12	24
WC-19	H	6 ft	10 ft 6.375 in.	2150/1500	36.97***	DP	12	24
WC-20‡	H	10 ft	19 ft 5.625 in.	10,000/7000	114.87***	mod DP	12	48

* Overall length and diameter given; entries in parentheses indicate estimates.

** V/H calculation includes 3/16-in. wall thickness for vertical tanks.

*** V/H depends on level in tank; mid-tank values given.

† Tank F-201 is currently not in use. If future use is planned, it will be leak tested prior to use.

‡ Leak test method and protocol not yet finalized.

3.3 Implementation of Leak Test Program

Figure 8 shows a priority matrix for testing the various tanks based on the risk and consequences of a leak and on the availability of data for initializing the leak test program. This matrix is taken from the correspondence from P. J. Halsey to R. C. Sleeman, "Submittal of *Leak Detection Priorities for Federal Facility Agreement Liquid Low-Level Waste Tanks Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee*" (see Appendix A). This correspondence provides testing priorities for the LLLW system and shows three categories of risk (high, medium, and low) and three categories related to the level of difficulty of testing the tanks (easy, difficult, and not feasible). As described in the FFA Plans and Schedules document [3], those portions of the matrix denoted with an "A" will receive the highest priority for leak detection testing, consistent with the data availability. Categories "B" and "C" will receive correspondingly reduced priority.

RISK	HIGH	W-16 WC-3 WC-7 WC-9 WC-10 A	T-1 T-2 W-12 WC-2 WC-19 A	HFIR D
	MODERATE	A	*F-111 *F-126 F-201 *S-223 F-501 *S-324 WC-20 *S-523 B	D
	LOW	*L-11 B	2026A *B-2-T *B-3-T *N-71 *C-6-T *P-3 **LA-104 *P-4 C	D
		EASY	DIFFICULT	NOT FEASIBLE
LEVEL OF DIFFICULTY OF TESTING				

A HIGHEST PRIORITY
B MODERATE PRIORITY
C LOW PRIORITY
D FURTHER EVALUATION AND DISCUSSION WITH EPA AND TDEC REQUIRED

*Category B tanks that meet FFA secondary containment requirements
** Moved to Category D

Figure 8. Priority matrix for leak detection tests of FFA LLLW tank systems.

Table 4 shows tank test priority. This table, which was prepared from the data in Figure 8 and the availability of sensor data, shows the schedule for the initial reporting of the leak test results as dates associated with various tanks. It is noted that some of the tanks in Table 4 do not show a leak test results report date. As noted above, this is because the tanks without reporting dates have passed the secondary containment design demonstrations and have been removed from the leak testing program.

Table 4. Tank Test Priority

High Priority	Moderate Priority	Low Priority
WC-9 (Jun '93)	F-201*	2026A (Mar '94)
WC-10 (Sep '93)	F-501 (Mar '94)	B-2-T
W-16 (Sep '93)	F-111	B-3-T
	F-126	
T-1 (Dec '93)	S-223	C-6-T
T-2 (Dec '93)	S-324	L-11
HFIR (Mar '95)	S-523	LA-104**
WC-2 (Dec '93)	WC-20 (Sept '95)	N-71
WC-3 (Jun '93)		P-3
WC-7 (Jun '93)		P-4
W-12 (Dec '93)		
WC-19 (Dec '93)		

* Tank F-201 is currently not in use. If future use is planned, it will be leak tested prior to use.

** Tank LA-104 has been moved to Category D.

The schedule for implementing the LLLW leak testing plan is shown in Figure 9. This figure (which appears as Figure 6.4 in the FFA Plans and Schedules document for ORNL [3]) incorporates the priorities discussed in Section 3.3 of this report, and it reflects the estimated technical effort required to execute the leak testing plan.

Figure 9. Leak detection test plan and schedule.

4 Documentation and Reporting

Each test that is performed on the LLLW tanks as part of the leak testing program will be documented by means of a report generated directly by the leak test software. This report, which will be archived, will describe the tank tested, the dates over which the test was done, the test result, and the names and signatures of the individual(s) who performed the test. In addition, the report will include the technical information necessary to support the result. This technical information will include the compensated volume rate, the average volume in the tank and the percent of full volume, the standard deviation of the compensated volume data (a measure of data quality—see the general leak testing plan [1]), and other test- and test-configuration-related information. In addition to the leak test report, the data will be archived in a digital format; summary information from each test, for each tank, will be also stored in a database.

In accordance with the FFA, documentation and reporting for tank systems that fail a test will be supplied to the EPA and TDEC within 24 h of the discovery of any evidence of a leak as determined by the leak test protocol. Additionally, all data are archived and are available for review upon request.

5 Summary and Conclusions

A detailed plan for leak testing a portion of the tanks in the active part of the LLLW system has been presented. The plan is consistent with the requirements of the FFA, and it is being implemented in a timely and cost-effective manner. Importantly, the plan rests on a sound technological foundation and provides the same degree of protection to the LLLW system as is required by the EPA for tank systems containing hazardous substances.

The leak testing plan addresses the individual LLLW tanks. This is necessary because of the variability in volume capacity among the many tanks and the way these tanks are installed and instrumented. In developing the plan, a substantial effort has been made to take advantage of existing instrumentation within the LLLW system, and existing practices, wherever possible and practical. This has advantages for the EPA, the TDEC, and ORNL in terms of time and cost.

A key feature of the plan is that it is based in part on relevant portions of current federal regulations that are applicable to underground storage tanks and pipelines that store and transfer petroleum products and other hazardous substances. There are three advantages to basing the plan on this federal regulation. First, the UST regulation has been accepted by industry and is being implemented by most states and local regulators. Second, the regulation provides quantitative performance standards by which to gauge the effectiveness of leak detection methods; it also provides a testing schedule for making the necessary measurements. Third, since the regulation is founded on existing technology, the physics of many of the leak testing methods applicable to the LLLW system are well understood, and the methods themselves can be demonstrated and implemented.

The leak testing plan is performance-based. That is, the tanks will be tested monthly, using methods that have a demonstrated performance for detecting leaks with a probability of detection of at least 95% (0.95) and a probability of false alarm of no more than 5% (0.05), and using a leak detection criterion of 0.2 gal/h. These elements clarify the requirements of the FFA, which does not specify leak testing frequency or approaches, or provide performance standards.

A further element of the plan is that the methods used to test each of the component parts of the LLLW system are consistent with the technology developed to help the UST industry comply with federal regulations for underground storage tanks. Thus, the plan takes advantage of the technological developments in the UST arena and applies them to the LLLW system.

This plan has described a leak testing program for the ORNL LLLW system. The plan is built upon sound engineering principles, existing federal regulations, and leak testing approaches that have been proven in the underground storage tank industry, as well as on the specific needs and operational requirements at ORNL. The plan emphasizes the use of existing instrumentation where possible, so that implementation may be both timely and cost-effective. When implemented, the ORNL LLLW leak testing plan can become a model for other sites with similar

waste management systems. It will feature quantified leak rate determination using instruments with known performance, testing with specific leak detection criteria, and a rigorous test schedule for each of the testable components of the system.

REFERENCES

1. D. G. Douglas, R. F. Wise, J. W. Starr, J. W. Maresca, Jr., "Leak Testing Plan for the Oak Ridge National Laboratory Liquid Low-Level Waste System (Active Tanks)," Volumes I through III, Martin Marietta Energy Systems Report No. ORNL/ER/Sub/92-SK263/1, prepared for Martin Marietta by Vista Research, Inc., Mountain View, California, under subcontract No. 12X-SK-263C (June 1992).
2. "Federal Facility Agreement for the Oak Ridge Reservation," United States Environmental Protection Agency Region IV, United States Department of Energy, and Tennessee Department of Environment and Conservation, Effective Date: January 1, 1992, DOE/OR-1014.
3. "Federal Facility Agreement Plans and Schedules for Liquid Low-Level Radioactive Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee," Report No. ES/ER-17&D1, prepared by the Waste Management and Remedial Action Division, Martin Marietta Energy Systems, Inc., Contract No. DE-AC05-84OR21400, Oak Ridge, Tennessee (March 1992).
4. "Design Demonstrations for Category B Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee," Report No. DOE/OR-1047&D2, prepared for U.S. Department of Energy, Office of Environmental Restoration and Waste Management, prepared by Ebasco (November 1994).
5. "Design Demonstrations for the Remaining 19 Category B Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee," Report No. DOE/OR/03-1150&D2, prepared for U. S. Department of Energy, Office of Environmental Restoration and Waste Management, prepared by Foster Wheeler Environmental Corp. (December 1994).
6. U.S. Environmental Protection Agency, "40 CFR 280 - Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks," *Federal Register*, 53: 185 (23 September 1988).

Appendix A

Leak Detection Testing Priorities

Ltr.# PIA-TP/92-108

MARTIN MARIETTA ENERGY SYSTEMS, INC.POST OFFICE BOX 2003
OAK RIDGE, TENNESSEE 37831

December 28, 1992

Mr. Robert C. Sleeman, Director
Environmental Restoration Division
DOE Oak Ridge Field Office
Post Office Box 2001
Oak Ridge, Tennessee 37831-8541

Dear Mr. Sleeman:

Submittal of Leak Detection Test Priorities for Federal Facility Agreement Liquid Low-Level Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee

Enclosed is the *Leak Detection Test Priorities for Federal Facility Agreement Liquid Low-Level Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, for your review and subsequent transmittal to the Tennessee Department of Environment and Conservation and the Environmental Protection Agency. The subject document is submitted in accordance with the Federal Facility Agreement (FFA) as an information only document and meets the scheduled milestone date of December 31, 1992, as stated in the *Federal Facilities Plans and Schedules for the Liquid Low-Level Radioactive Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (ES/ER-17&D1).

The subject document provides a prioritization of liquid low-level waste (LLLW) tank systems for leak testing. The ranking, based on the relative potential for system leakage and associated consequences for the LLLW system components (i.e., inlet lines, area collection tanks, and discharge lines), establishes three classes of leak testing priority: low, moderate, or high. Included in the ranking are the FFA Category C tank systems and the FFA Category B tank systems that require upgrades to meet secondary containment requirements.

We do not anticipate comments on this document because it is issued only for information that will be used to establish the *ORNL Active LLLW Tank Leak Detection Test Plans and Schedules* document as proposed in Appendix E of the FFA as a March 31, 1993, milestone.

However, if you have any questions regarding this information, please contact Patricia Halsey (6-4025) or Amber Clay (4-6600).

Sincerely,

P. J. Halsey, Manager
FFA and TOA Implementation
Program Integration & Administration Division

PJH:jwf

Enclosure

**LEAK TESTING PRIORITY
for
FEDERAL FACILITY AGREEMENT
LIQUID LOW-LEVEL WASTE TANK SYSTEMS**

The priority for leak testing tanks was established by a group of experienced personnel who are familiar with ORNL program operations as well as the operation of the Liquid Low-Level Waste (LLLW) System.

The ranking includes the Federal Facility Agreement (FFA) Category C tank systems and the Category B tank systems that do not meet secondary containment requirements.

The primary criterion was Leak Potential, which considered tank materials, secondary containment, construction and age. The secondary criterion was Content Hazard, which considered waste contents and usage.

Using these criteria, the group divided the tanks into three priorities, high, moderate, and low. Within each of these three groups, the leak test order will be determined by the physical demands of the leak testing operation itself. Leak testing will begin first on those tanks that already have, or can be easily equipped with, the necessary instrumentation. This approach will ensure maximum efficiency in completing the overall leak testing program by beginning on those tanks that can be readily tested while tank outfitting continues in parallel on those tanks requiring instrumentation upgrade. Instrumentation upgrades for tanks in the high priority group are underway.

**Leak Detection Test
Priority Matrix
FFA LLLW Tank Systems**

RISK	High	W-16 WC-3 WC-7 WC-9 WC-10	A	T-1 T-2 W-12 WC-2 WC-19	A	HFIR	D
	Moderate		A	*F-111 *F-126 *F-201 *F-501 *WC-20	B	*S-223 *S-324 *S-523	D
	Low	*L-11	B	*2026A *B-2-T *B-3-T *C-6-T *LA-104	C	*N-71 *P-3 *P-4	D
		Easy		Difficult		Not Feasible	
DIFFICULTY OF TESTING							

- A** Highest leak detection test priority
- B** Moderate leak detection test priority
- C** Low leak detection test priority
- D** Further evaluation and discussion with
EPA and TDEC required

***Category B tank systems that require upgrade to
meet FFA secondary containment requirements.**

Appendix B

DOE/EPA/TDEC Correspondence

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY DRIVE
OAK RIDGE, TENNESSEE 37830-7072

July 1, 1993

Mr. Nelson Lingle
Environmental Restoration Division
Department of Energy
P.O. Box 2001
Oak Ridge, Tennessee 37831-8541

RE: Detailed Leak Detection Test Plan and Schedule for the Oak Ridge National Laboratory LLLW Active Tanks

Dear Mr. Lingle:

The Tennessee Department of Environment and Conservation, DOE Oversight Division has reviewed the above referenced document pursuant to the Federal Facilities Agreement for the Oak Ridge Reservation. The following are comments relevant to that document review.

Specific Comments:

Page 3, paragraph 3

Comment: Design demonstrations for Category B tanks were not submitted to TDEC until June 30, 1993. The State is currently reviewing design demonstrations for all Category B tank systems.

Page 12, Section 3.1.3

Comment: If a leak test repetitively produces results which are inconclusive, what are the contingency plans to reach a decision concerning the integrity of the tank? Also, does DOE intend to notify EPA and TDEC if a leak test is inconclusive?

018632

Questions or comments concerning the contents of this letter should be directed to Randy Young at the above address or by phone at (615) 481-0995.

Sincerely,

R. Doug McCoy
Manager
Environmental Restoration Section

cc: Craig Brown - EPA

er0218.08

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY DRIVE
OAK RIDGE, TENNESSEE 37830-7072

December 20, 1993

Mr. Nelson Lingle, Director
Environmental Restoration Division
U.S. Department of Energy
P.O. Box 2001
Oak Ridge, TN 37831-8541

Dear Mr. Lingle

RE Leak Testing of Liquid Low-Level Waste (LLLW) Tanks at the Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee

On November 19, 1993, representatives of the Tennessee Department of Environment and Conservation, DOE Oversight Division (TDEC/DOE-O) and Martin Marietta Energy Systems (MMES) met to discuss leak testing of LLLW tank systems at ORNL as required by the Federal Facilities Agreement (FFA). At the present time, DOE has developed a leak testing plan, prioritized tank systems, and began testing several tanks.

The primary focus of the meeting was to discuss problems associated with interpreting data gathered from the tests. The data does not provide the statistical confidence to confirm that a tank is not leaking (i.e., the data shows results to be "inconclusive"). The details surrounding why the tests prove inconclusive were discussed in the meeting and will not be reiterated in this correspondence. However, DOE-O would like to formally state that actions need to be planned immediately to resolve this situation. The value of continuing to accept inconclusive test results for tank systems which do not have secondary containment is debatable. Likewise, the value of spending millions of dollars to modify tank systems which are scheduled to be removed from service in the near future is also debatable.

Mr. Nelson Lingle
December 20, 1993
Page Two

The State requests DOE respond to this situation by January 31, 1994. The response should include alternatives for resolving this situation, rough cost estimates and time schedules, and a recommendation of the proposed course of action.

Direct questions and requests for information to Mr. Randy Young or Mr. Curt Myers at (615) 481-0993.

Sincerely,

R. Doug McCoy, Manager
Environmental Restoration Section

sac

cc Craig Brown, EPA

er0313.02

Department of Energy

Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831—8541

February 15, 1994

Mr. Craig Brown
U. S. Environmental Protection Agency,
Region IV
345 Courtland Street, N. E.
Atlanta, Georgia 30365

↑
FEB 21 1994
RECEIVED

Mr. Doug McCoy, FFA Project Manager
DOE Oversight Division
Tennessee Department of Environment
and Conservation
761 Emory Valley Road
Oak Ridge, Tennessee 37830-7072

Dear Gentlemen:

FEDERAL FACILITY AGREEMENT - ADDITIONAL INFORMATION REGARDING LEAK TESTING

Reference: Letter from R. Doug McCoy to Nelson Lingle, "Leak Testing of Liquid Low-Level Waste (LLLW) Tanks at the Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee," December 20, 1993

The above referenced letter is a result of an informational meeting held on November 19, 1993, with personnel from the Tennessee Department of Environment and Conservation (TDEC), the Department of Energy, Oak Ridge Operations Office, and Martin Marietta Energy Systems, Inc. The purpose of the meeting was to discuss leak testing of LLLW tanks at ORNL and the fact that the results of some tests are inconclusive.

As noted in the referenced letter, the analysis of the data from tank leak testing sometimes results in an inclusive test result. As explained in the meeting, inconclusive results are generally due to poor data quality. During these tests, an upward trend in the volume measurements is sometimes evident, signifying that an inflow of waste is present. Typically, inflows cause a lack of good correlation (i.e., data quality) between the volume measurements over time and the best data fit (volume change rate). The possible sources of the upward volume trend in tank testing were discussed, and it is known that some volume of non-programmatic waste is flowing into several of the tanks being tested. An example of this type of input would be the drains from the radioactive off-gas system. Historically, these drains have been connected directly to the LLLW System to collect any condensation or other liquid in the off-gas system that could potentially be contaminated to a level considered LLLW.

As discussed in the November meeting, the current leak testing procedures provide evidence that the condition of the tank is acceptable for receiving and storing waste even though inconclusive (with an evident upward volume trend) or inflow results were obtained.

Mr. Craig Brown
Mr. Doug McCoy

-2-

Due to the frequent detailed analysis of the volume data in the tanks, any shift in the normal inflow trends (such as a downward trend) can be identified, appropriate actions will be taken and notifications made.

For example, the WC-10 Tank System at ORNL is one of five Category C tanks that remain in interim service with an environmental, safety, and health exemption. Tank WC-10 is subject to monthly leak testing until removed from service. It services the facilities in the Isotope Circle area and is needed to support the decontamination and decommissioning activities in the Isotopes Facility Shutdown Program.

Currently, work is under way to identify and eliminate or re-route sources of non-programmatic waste into Tank WC-10. For example, work is being initiated to re-route the off-gas drains at Buildings 3033 and 3047 and to isolate cell ventilation, fan housing, and the 3039 stack drains. In addition, action is under way to evaluate diversion of other sources, to verify closure of deactivated drains, and to search for any additional sources of non-programmatic waste going to Tank WC-10. These activities will reduce the amount of non-programmatic waste entering Tank WC-10 that must be collected and treated and should improve the future leak test results for Tank WC-10.

Another comment in the letter questions the value of spending millions of dollars to modify tank systems which are scheduled to be removed from service in the near future. The planning and actions currently under way are consistent with your comment. However, it is necessary to make some modifications to these tank systems to eliminate inputs prior to removal from service to isolate the tank systems for remediation. These actions take into account the risk and volumes of waste generated by these sources and the cost and personnel exposure to make the changes. In the case of Tank WC-10, the modifications identified to date are not major in cost or scope. The additional benefit of the elimination of inputs will include improving leak testing results and the cost savings realized by reducing the volume of LLLW to be treated and stored.

Any questions or additional requests for information regarding the leak test results and the planned course of action should be directed to Mac Roddye at (615) 576-1801 or Cavanaugh Mims at (615) 576-9481.

Sincerely,

W. Nelson Lingle, Chief
Oak Ridge Remediation Branch

cc:

C. Pilj, EM-321, TREV II
C. Mims, EW-911, OR
J. Sweeney EW-911, OR
P. Halsey, 1310-J, MS 7256
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