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**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Level Trend Analysis Summary Report for
Oak Ridge National Laboratory Inactive
Liquid Low-Level Waste Tanks**

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

**Level Trend Analysis Summary Report for Oak Ridge National
Laboratory Inactive Liquid Low-Level Waste Tanks**

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EXECUTIVE SUMMARY

Oak Ridge National Laboratory, located 25 miles west of Knoxville, Tennessee, began operating in 1943. The facility is currently managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy (DOE) and is part of DOE's Oak Ridge Reservation. Facility operations have produced liquid low-level waste (LLLW) that is radioactive and/or hazardous. Storage tanks have been used to collect and store these wastes. Most of the collection system, including the tanks, is located below the ground surface.

Many of the systems have been removed from service (i.e., are now inactive) but contain residual amounts of waste liquid and sludges. A plan of action has been developed by DOE to ensure that environmental impacts from the waste remaining in the inactive tank systems are minimized. This report is being submitted to the Environmental Protection Agency Region IV, the Tennessee Department of Environment and Conservation, and DOE for information only.

The Federal Facility Agreement (FFA) does not require any type of testing or monitoring for the inactive LLLW tanks that are removed from service but does require waste characterization of tank contents, risk characterization of tanks removed from service, and remediation of the inactive tanks and their contents. This report is for information only and is not required by the FFA. It includes a description of the methodology and results of level trend analyses for the Category D tanks listed in the FFA that currently belong to the Environmental Restoration Program.

1. INTRODUCTION

1.1 BACKGROUND

Oak Ridge National Laboratory (ORNL), located 25 miles west of Knoxville, Tennessee, began operating in 1943. The facility is currently managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy (DOE) and is part of DOE's Oak Ridge Reservation (ORR). Facility operations have produced liquid low-level waste (LLLW) that is radioactive and/or hazardous. Storage tanks have been used to collect and store these wastes. Most of the collection system, including the tanks, is located below the ground surface.

Many of the systems have been removed from service (i.e., are inactive) but contain residual amounts of waste liquid and sludges. A plan of action has been developed by DOE to ensure that environmental impacts from the waste remaining in the inactive tank systems are minimized. This plan is consistent with the Federal Facility Agreement (FFA) negotiated among the Environmental Protection Agency Region IV, the Tennessee Department of Environment and Conservation, and DOE, which sets forth the requirements for investigation and remediation of the inactive and active LLLW storage tanks. This summary report on the inactive LLLW tanks is for information purposes only and is not a requirement of the FFA.

1.2 PURPOSE

The FFA does not require any type of testing or monitoring for the inactive LLLW tanks that have been removed from service but does require waste characterization of tank contents, risk characterization of the tanks removed from service, and remediation of the inactive tanks and their contents. The level trend analyses of inactive LLLW tanks summarized in this report are provided for information only for continued surveillance, maintenance, and management of this group of tanks pending final remediation of the tanks and their contents.

1.3 SCOPE

This document is limited to the LLLW tanks at ORNL that currently belong to the Environmental Restoration (ER) Program and are listed as Category D [existing tank system(s) without secondary containment that are removed from service] in Appendix F of the FFA. Not all Category D tanks belong to the ER Program at this time.

A tank can be influenced by ancillary systems such as connected piping and/or access ports that have not been isolated from the tanks. Leaks in these ancillary systems could contribute to any changing level trends in the data.

1.4 DEFINITIONS

Guniting—A construction process in which concrete is applied in layers by spraying over formed steel reinforcement bars and welded wire mesh.

Level Trend Analysis—The collection and evaluation of data concerning the level of liquid tank contents using linear regression analysis to determine the level trend.

Inactive Tank—A liquid low-level waste tank that has been permanently removed from service (FFA Category D).

Infiltration—The movement of water from precipitation downward through the surface of the earth; such movement may be enhanced by man-made structures such as piping or trenching.

2. LEVEL TREND SUMMARY FOR INACTIVE TANKS

The inactive tanks at ORNL contain radioactive and/or hazardous residual liquids. The residual contents vary in volume from less than 50 gal in some tanks to over 120,000 gal in others. Measurements of the liquid level in each tank have been recorded, and the liquid level trend is evaluated by performing linear regression analysis on the collected data. The liquid inventory has been assumed constant (i.e., process discharges to the tank have stopped) because the tanks are inactive. However, operators of the Gunite™ tanks and some of the steel tanks suspect, and video inspections indicate, that the tanks receive infiltration from inflow of groundwater and/or surface runoff. Such infiltration is reflected in positive (i.e., increasing) level trends in many of the tanks during periods of moderate to high precipitation. These tanks are being monitored on a daily basis under the Surveillance and Maintenance program by Energy Systems. Data are being collected and evaluated periodically to monitor for apparent changes in level trends. Changes in trends can be a result of real level changes or malfunctions in instrumentation, signaling the need for maintenance.

Because infiltration and inflow of liquid into the tank and lines can mask liquid losses from the tank, the level trend analysis indicates the net level trend and is not an absolute measure of inflow or outflow. The calculated level trend is expressed as a rate of level change in gallons per day. This rate is valid for the period evaluated and may vary significantly during other periods because of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration. The rate of change indicated by the level trend cannot be compared between tanks because it indicates not a rate of flow but a net change in level, which can result from simultaneous inflow and outflow. The analysis cannot indicate the consistency of the observed trend, identify when it began, or predict how long it will persist. The approach is explained in greater detail in Appendix A.

Tanks W-6 to W-10 in the South Tank Farm are connected to a ventilation system designed to maintain the tanks at a slight negative pressure and to ensure that air flow is constantly into and not out of the tanks. This system results in continuous air changes in the headspace in these tanks and can therefore be expected to result in evaporative losses from the tanks, the rate of which depends upon the relative humidity and temperature of the air being drawn into the tanks (which is not presently being measured). The result of this effect is likely to be observed during periods of little or no precipitation, when there is decreased infiltration into these tanks. Because of the low total precipitation received locally during the 92-day data collection period evaluated in this report, those tanks that normally receive lesser rates of infiltration can be expected to exhibit a net decrease in level for the period.

The following pages contain the results of the level trend analysis of each tank. No level trend analysis was performed on existing inactive tanks that are empty or scheduled to have their contents removed to the Process Waste Treatment Plant. If a level trend analysis is not performed, the rationale for not performing the analysis is presented.

2.1 TANK H-209

2.1.1 Tank Level Trend Analysis Summary

Tank H-209 has had its contents removed and is being monitored; therefore, no level trend analysis will be performed on the tank.

2.1.2 Standards for Level Trend Analysis

Not applicable.

2.1.3 Supplemental Information

Tank H-209, located at the southwest corner of Building 3517 in the main plant area of ORNL, has an estimated 2500-gal capacity.

No service information is available.

2.2 TANK T1

2.2.1 Tank Level Trend Analysis Summary

During 92 days from August 1, 1993, through October 31, 1993, the calculated mean increasing level trend was 0.11 gal/d. This level trend is valid for the period evaluated but may vary during other periods as a result of changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.2.2 Tank and Level Monitoring Equipment Description

Tank T1, a horizontal steel tank located at the Old Hydrofracture Facility of ORNL, has a capacity of 15,000 gal with a residual volume of ~8,569 gal. There is no known inflow or outflow. The liquid level is monitored with a pneumatic gage system maintained by ORNL. The gage indicates percentage of volume, which is converted to volume in gallons using a conversion table. A schematic drawing of the tank is shown in Fig. 2.2.1.

2.2.3 Results of Level Trend Analysis

During the 92 days from August 1 through October 31, 1993, the mean level trend and standard error were calculated as 0.11 (increasing) and 0.43 gal/d respectively. The 95% lower confidence limit is negative at -0.73 gal/d, and the upper limit is positive at 0.95 gal/d. Therefore, neither an increasing nor decreasing level trend was established with 95% probability based on the collected data. The level data are presented graphically in Fig. 2.2.2.

2.2.4 Supplemental Information

Tank T1 is mounted on a concrete slab that is sloped to drain to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.2.1. Schematic of Tank T1.

Fig. 2.2.2. Tank T1 level data.

2.3 TANK T2

2.3.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993, through October 31, 1993, the calculated mean decreasing level trend was -1.06 gal/d. This level trend is valid for the period evaluated but may vary during other periods as a result of changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.3.2 Tank and Level Monitoring Equipment Description

Tank T2, a horizontal steel tank located at the Old Hydrofracture Facility of ORNL, has a capacity of 15,000 gal with a residual volume of $\sim 10,687$ gal. There is no known inflow or outflow. The liquid level is monitored with a pneumatic gage system maintained by ORNL. The gage indicates percentage of volume, which is converted to volume in gallons using a conversion table. A schematic drawing of the tank is shown in Fig. 2.3.1.

2.3.3 Results of Level Trend Analysis

During the 92 days from August 1 through October 31, 1993, the mean level trend and standard error were calculated as -1.06 (decreasing) and 0.41 gal/d respectively. The 95% upper confidence limit is -0.25 gal/d. The level trend has a 95% probability of being negative, greater than, or equal to -0.25 gal/d based on the collected data. The level data are presented graphically in Fig. 2.3.2.

2.3.4 Supplemental Information

Tank T2 is mounted on a concrete slab that is sloped to drain to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.3.1. Schematic of Tank T2.

Fig. 2.3.2. Tank T2 level data.

2.4 TANK T3

2.4.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993, through October 31, 1993, the calculated mean decreasing level trend was -0.17 gal/d. This level trend is valid for the period evaluated but may vary during other periods as a result of changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.4.2 Tank and Level Monitoring Equipment Description

Tank T3 is a horizontal steel tank located at the Old Hydrofracture Facility of ORNL with a capacity of 25,000 gal and a residual volume of $\sim 2,825$ gal. There is no known inflow or outflow. The liquid level is monitored with a pneumatic gage system maintained by ORNL. The gage indicates percentage of volume, which is converted to volume in gallons using a conversion table. A schematic drawing of the tank is shown in Fig. 2.4.1.

2.4.3 Results of Level Trend Analysis

During the 92 days from August 1 through October 31, 1993, the mean level trend and standard error were calculated as -0.17 (decreasing) and 0.40 gal/d respectively. The 95% lower confidence limit is negative at -0.97 gal/d, and the upper limit is positive at 0.62 gal/d. Therefore, neither an increasing nor decreasing level trend was established with 95% probability based on the collected data. The level data are presented graphically in Fig. 2.4.2.

2.4.4 Supplemental Information

Tank T3 is mounted on a concrete slab that is sloped to drain to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.4.1. Schematic of Tank T3.

ORNL-DWG 94-2078

Fig. 2.4.2. Tank T3 level data.

2.5 TANK T4

2.5.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993, through October 31, 1993, the calculated mean decreasing level trend was -2.52 gal/d. This level trend is valid for the period evaluated but may vary during other periods as a result of changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.5.2 Tank and Level Monitoring Equipment Description

Tank T4, a horizontal steel tank located at the Old Hydrofracture Facility of ORNL, has a capacity of 25,000 gal with a residual volume of $\sim 14,888$ gal. Introduction of liquids was stopped in 1980 when the tank was removed from service. The liquid level is monitored with a pneumatic gage system maintained by ORNL. The gage indicates percentage of volume, which is converted to volume in gallons using a conversion table. A schematic drawing of the tank is shown in Fig. 2.5.1.

2.5.3 Results of Level Trend Analysis

During the 92 days from August 1 through October 31, 1993, the mean level trend and standard error were calculated as -2.52 (decreasing) and 0.55 gal/d respectively. The 95% upper confidence limit is -1.43 gal/d. The level trend is downward with a 95% probability of being greater than or equal to -1.43 gal/d based on the collected data. The level data are presented graphically in Fig. 2.5.2.

2.5.4 Supplemental Information

Tank T4 is mounted on a concrete slab that is sloped to drain to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.5.1. Schematic of Tank T4.

Fig. 2.5.2. Tank T4 level data.

2.6 TANK T9

2.6.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993, through October 31, 1993, the calculated mean increasing level trend was 1.83 gal/d. This level trend is valid for the period evaluated but may vary during other periods as a result of changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.6.2 Tank and Level Monitoring Equipment Description

Tank T9 is a horizontal steel tank located at the Old Hydrofracture Facility of ORNL with a 13,000-gal capacity and a residual volume of ~4,869 gal. There is no known inflow or outflow. The liquid level is monitored with a pneumatic gage system maintained by ORNL. The gage indicates percentage of volume, which is converted to volume in gallons using a conversion table. A schematic drawing of the tank is shown in Fig. 2.6.1.

2.6.3 Results of Level Trend Analysis

During the 92 days from August 1 through October 31, 1993, the mean level trend and standard error were calculated as 1.83 (increasing) and 0.56 gal/d respectively. The 95% lower confidence limit is 0.73 gal/d. The level trend is upward with a 95% probability of being greater than or equal to 0.73 gal/d based on the collected data. The level data are presented graphically in Fig. 2.6.2.

2.6.4 Supplemental Information

Tank T9 is mounted on a concrete slab that is sloped to drain to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.6.1. Schematic of Tank T9.

Fig. 2.6.2. Tank T9 level data.

2.7 TANK T-30

2.7.1 Tank Level Trend Analysis

Tank T-30 is empty; therefore, no level trend analysis will be performed on the tank.

2.7.2 Standards for Level Trend Analysis

Not applicable.

2.7.3 Supplemental Information

Tank T-30, located south of Building 4507 in the main plant area of ORNL, is a vertical, stainless steel tank with an 825-gal capacity. There is no known inflow or outflow. The liquid contents have been removed, and the tank is being monitored. A schematic drawing of the tank is shown in Fig. 2.7.1.

No leaks have been reported from Tank T-30. The tank is mounted in a concrete, stainless steel-lined vault for approximately half the wall height. The vault is reported to receive some infiltration.

Fig. 2.7.1. Schematic of Tank T-30.

2.8 TANK TH-1

2.8.1 Tank Level Trend Analysis Summary

Tank TH-1 is empty; therefore, no level trend analysis will be performed on the tank.

2.8.2 Standards for Level Trend Analysis

Not applicable.

2.8.3 Supplemental Information

Tank TH-1, located south of Building 3503 in the main plant area of ORNL, is a vertical, stainless steel tank with a 2500-gal capacity. There is no known inflow or outflow. The liquid contents have been removed, and the tank is being monitored. A schematic drawing of the tank is shown in Fig. 2.8.1.

No leaks have been reported into or out of Tank TH-1.

Fig. 2.8.1. Schematic of Tank TH-1.

2.9 TANK TH-2

2.9.1 Tank Level Trend Analysis Summary

Tank TH-2 is empty; therefore, no level trend analysis will be performed on the tank.

2.9.2 Standards for Level Trend Analysis

Not applicable.

2.9.3 Supplemental Information

Tank TH-2, located south of Building 3503 in the main plant area of ORNL, is a vertical, stainless steel tank with a 2400-gal capacity and a residual volume of ~70 gal with no sludge. There is no known inflow or outflow. The liquid contents have been removed, and the tank is being monitored. A schematic drawing of the tank is shown in Fig. 2.9.1.

No leaks have been reported into or out of Tank TH-2.

Fig. 2.9.1. Schematic of Tank TH-2.

2.10 TANK TH-3

2.10.1 Tank Level Trend Analysis Summary

Tank TH-3 is empty; therefore, no level trend analysis will be performed on the tank.

2.10.2 Standards for Level Trend Analysis

Not applicable.

2.10.3 Supplemental Information

Tank TH-3, located south of Building 3503 in the main plant area of ORNL, is a vertical, stainless steel tank with a 3300-gal capacity. The liquid contents have been removed, and the tank is being monitored. There is no known inflow or outflow from the tank. A schematic drawing of the tank is shown in Fig. 2.10.1.

No leaks have been reported into or out of Tank TH-3.

Fig. 2.10.1. Schematic of Tank TH-3.

2.11 TANK TH-4

2.11.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993, through October 31, 1993, the tank was full beyond capacity, and the liquid level was up in the terra cotta riser pipe in which the level monitor is mounted. The riser is tilted about 15° off vertical and may have a poor seal to the top of the tank. The level fluctuated up and down during the period of the test, probably reflecting changes in liquid temperature and other environmental factors that can influence measured liquid levels.

2.11.2 Tank and Level Monitoring Equipment Description

Tank TH-4, located southwest of Building 3500 in the main plant area of ORNL, is a vertical Gunitite™ tank with a 14,000-gal capacity rated at the beginning of the dome and a residual volume of ~17,518 gal. The tank had earlier been reported to be full beyond its rated capacity (DOE/OR/01-1138&D1). There is no known process inflow or outflow.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.11.1.

2.11.3 Results of Level Trend Analysis

The level trend was calculated during 92 days from August 1 through October 31, 1993. Measurements indicated a net decreasing level trend of -1.80 gal/d with a standard error of 0.94 gal/d over this period. The level fluctuation resulted in a 95% upper confidence limit of 0.05 gal/d (upward) and a 95% lower confidence limit of -3.65 gal/d (downward), which results in an indeterminant trend. This wide fluctuation in data is at least partly due to the fact that the liquid level is up in the riser pipe, which results in a very small liquid surface area. The small surface area is extremely sensitive to minor changes in volume, and the level monitor calibration range is not capable of compensating for the difference between the surface area of liquid in the full tank diameter and the surface area of liquid in the riser. The level data are presented graphically in Fig. 2.11.2.

2.11.4 Supplemental Information

Review of available documents related to operation of this tank did not reveal reports of leaks, but the interpretation of data indicates probable inleakage at the tank-to-riser connection.

2.11.5 References

H&R Technical Associates, Inc., March 1993, *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Fig. 2.11.1. Schematic of Tank TH-4.

Fig. 2.11.2. Tank TH-4 level data.

2.12 TANK W-1

2.12.1 Tank Level Trend Analysis Summary

During the 92 days (89 days of data) from August 1, 1993 through October 31, 1993, the calculated mean increasing trend rate was 0.02 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence measured liquid levels.

2.12.2 Tank and Level Monitoring Equipment Description

Tank W-1, located in the North Tank Farm in the main plant area of ORNL, is a vertical, Gunite™ tank with a 4800-gal capacity. The residual volume in the tank had earlier been reported to be 378 gallons (DOE/OR/01-1138&D1). The approximate volume monitored as of December 1993 was 519 gallons. There is no known process inflow or outflow.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.12.1.

2.12.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend was increasing at 0.02 gpd with a standard error of 0.01 gpd. The 95% lower confidence limit was increasing at 0.01 gpd. The level trend is upward with a 95% probability of being greater than or equal to 0.01 gpd based on the collected data. The level data are presented graphically in Fig. 2.12.2.

2.12.4 Supplemental Information

The tank or inlet lines were suspected to be leaking, and the tank was removed from service. Inleakage has been observed to occur as a result of infiltration during periods of high precipitation.

2.12.5 References

H&R Technical Associates, Inc. March 1993, *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Fig. 2.12.1. Schematic of Tank W-1.

Fig. 2.12.2. Tank W-1 level data.

2.13 TANK W-1A

2.13.1 Tank Level Trend Analysis Summary

Tank W-1A is monitored with pneumatic level monitoring equipment. The tank receives infiltration from attached inlet piping during periods of high precipitation and is pumped out frequently. Therefore, a level trend analysis was not performed on the tank.

2.13.2 Standards for Level Trend Analysis

Tank W-1A, located in the North Tank Farm in the main plant area of ORNL, is a horizontal, stainless steel tank with a 4000-gal capacity. The residual volume in the tank varies because of frequent infiltration and prompt removal (DOE/OR/01-1138&D1). A schematic drawing of the tank is shown in Fig. 2.13.1.

2.13.3 Supplemental Information

The contents of the tank are frequently jettied to the active tank system.

2.13.4 References

H&R Technical Associates, Inc., March 1993, *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Fig. 2.13.1. Schematic of Tank W-1A.

2.14 TANK W-2

2.14.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean increasing level trend was 0.12 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence measured liquid levels.

2.14.2 Tank and Level Monitoring Equipment Description

Tank W-2, located in the North Tank Farm in the main plant area of ORNL, is a vertical, Gunitite™ tank with a 4800-gal capacity and as of December 1993 a residual volume of approximately 1,330 gal. There is no known process inflow or outflow.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.14.1.

2.14.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 0.12 gpd (increasing) and 0.01 gpd, respectively. The 95% lower confidence limit is 0.10 gpd. The upward level trend has a 95% probability of being greater than 0.10 gpd based on the collected data. The level data are presented graphically in Fig. 2.14.2.

2.14.4 Supplemental Information

The tank or inlet lines were suspected of leaking, and the tank was removed from service.

Fig. 2.14.1. Schematic of Tank W-2.

Fig. 2.14.2. Tank W-2 level data.

2.15 TANK W-3

2.15.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean increasing level trend was 5.32 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.15.2 Tank and Level Monitoring Equipment Description

Tank W-3, located in the North Tank Farm in the main plant area of ORNL, is a vertical, Gunitite™ tank with a 42,500-gal capacity. As of December 1993, the tank contains approximately 40,063 gallons of infiltrated water from surface runoff and/or groundwater. Inflow from process sources was stopped in the 1960s when the tank was removed from service.

The liquid level is monitored with a float and staff gage. The gage measures level through the use of a float that follows the liquid motion vertically. A staff attached to the float extends to the surface, where the motion of the float and staff can be observed. The staff is equipped with a pointer that indicates the relative motion of the liquid in inches on a graduated, vertically mounted rule. The vertical motion is recorded daily on a log sheet and is manually converted to volume of liquid of the tank. A schematic drawing of the tank is shown in Fig. 2.15.1.

2.15.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 5.32 gpd (increasing) and 0.70 gpd, respectively. The 95% lower confidence limit is 3.94 gpd. The upward level trend has a 95% probability of being greater than or equal to 3.94 gpd based on the collected data. The level data are presented graphically in Fig. 2.15.2.

2.15.4 Supplemental Information

The tank was removed from service and emptied during the 1960s because of groundwater infiltration, which accounts for most or all of the present contents.

2.15.5 References

H&R Technical Associates, Inc. March 1993, *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Fig. 2.15.1. Schematic of Tank W-3.

Fig. 2.15.2. Tank W-3 level data.

2.16 TANK W-4

2.16.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean level trend was 0.72 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.16.2 Tank and Level Monitoring Equipment Description

Tank W-4, located in the North Tank Farm in the main plant area of ORNL, is a vertical Gunitite™ tank with a 42,500-gal capacity. Inflow from process sources was stopped in the 1960s when the tank was removed from service. As of December 1993, the tank contains approximately 24,854 gallons of infiltrated water from surface runoff and/or groundwater.

The liquid level is monitored with a float and staff gage. The gage measures level through the use of a float that follows the liquid motion vertically. A staff attached to the float extends to the surface where the motion of the float and staff can be observed. The staff is equipped with a pointer that indicates the relative motion of the liquid in inches on a graduated vertically mounted rule. The vertical motion is recorded daily on a log sheet and is manually converted to volume of liquid of the tank. A schematic drawing of the tank is shown in Fig. 2.16.1.

2.16.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 0.72 gpd (increasing) and 0.60 gpd, respectively. The 95% lower confidence limit is -0.46 gpd and the 95% upper confidence limit is 1.90 gpd. Therefore, neither an increasing nor decreasing level trend was established with 95% probability based on the collected data. The level data are presented graphically in Fig. 2.16.2.

2.16.4 Supplemental Information

The tank was removed from service and emptied during the 1960s because of groundwater infiltration.

Fig. 2.16.1. Schematic of Tank W-4.

Fig. 2.16.2. Tank W-4 level data.

2.17 TANK W-5

2.17.1 Tank Level Trend Analysis Summary

The level trend analysis was performed over a period of 92 days beginning August 1, 1993 through October 31, 1993. The calculated mean decreasing level trend, -2.87 gpd, is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.17.2 Tank and Level Monitoring Equipment Description

Tank W-5, located in the South Tank Farm in the main plant area of ORNL, is a vertical tank constructed of Gunitite™ with a 170,000-gal capacity and as of December 1993 an estimated residual volume of waste of 21,636 gal. Inflow from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.17.1.

2.17.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as -2.87 gpd and 0.26 gpd, respectively. The 95% upper confidence limit is -2.35 gpd. The downward level trend has a 95% probability of being greater than or equal to -2.35 gpd based on the collected data. The level data are presented graphically in Fig. 2.17.2.

2.17.4 Supplemental Information

Most of the contents of Tank W-5 were removed during the 1982 sludge removal effort. The liquids entering the tank are believed to be the result of infiltration from runoff or groundwater. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.17.1. Schematic of Tank W-5.

Fig. 2.172. Tank W-5 level data.

2.18 TANK W-6

2.18.1 Tank Level Trend Analysis Summary

During the 92 days beginning August 1, 1993 and ending October 31, 1993, the calculated mean increasing level trend was 4.71 gpd. This level trend is valid for the period evaluated and may vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.18.2 Tank and Level Monitoring Equipment Description

Tank W-6, located in the South Tank Farm in the main plant area of ORNL, is a vertical Gunitite™ tank with a 170,000-gal capacity and as December 1993 an estimated residual waste volume of 123,276 gal. Inflow from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.18.1.

2.18.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 4.71 gpd (increasing) and 0.25 gpd respectively. The 95% lower confidence limit is 4.22 gpd. The upward level trend has a 95% probability of being greater than or equal to 4.22 gpd based on the collected data. The level data are presented graphically in Fig. 2.18.2.

2.18.4 Supplemental Information

Most of the contents of Tank W-6 were removed during the 1982 sludge removal effort. Current volume readings of approximately 123,276 gal indicate that the level has been increasing for the past several years.

The liquids entering the tank are believed to result from infiltration from surface runoff or groundwater. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.18.1 Schematic of Tank W-6

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Tank W-6

Fig. 2.18.2. Tank W-6 level data.

2.19 TANK W-7

2.19.1 Tank Level Trend Analysis Summary

The level trend analysis was performed over a period of 92 days beginning August 1, 1993 through October 31, 1993. The calculated mean decreasing level trend was -1.69 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.19.2 Tank and Level Monitoring Equipment Description

Tank W-7, located in the South Tank Farm in the main plant area of ORNL, is a vertical Gunite™ tank with a 170,000-gal capacity and as of December 1993 an estimated residual waste volume of 3,801 gal. Inflow into the tank from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.19.1.

2.19.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the magnitude of the mean level trend and standard error were calculated as -1.69 gpd (decreasing) and 0.28 gpd, respectively. The 95% upper confidence limit is -1.15 gpd. The downward trend has a 95% probability of being greater than or equal to -1.15 gpd based on the collected data. The level data are presented graphically in Fig. 2.19.2.

2.19.4 Supplemental Information

Most of the contents of Tank W-7 were removed during the 1982 sludge removal effort. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.19.1. Schematic of Tank W-7.

Fig. 2.192. Tank W-7 level data.

2.20 TANK W-8

2.20.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean decreasing level trend was -1.45 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.20.2 Tank and Level Monitoring Equipment Description

Tank W-8, located in the South Tank Farm in the main plant area of ORNL, is a vertical Gunitite™ tank with a 170,000-gal capacity and as of December 1993 an estimated residual waste volume of 50,040 gal. Inflow from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry entered into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.20.1.

2.20.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as -1.45 gpd (decreasing) and 0.30 gpd respectively. The 95% upper confidence limit is -0.87 gpd. The downward level trend has a 95% probability of being greater than or equal to -0.87 gpd on the basis of the collected data. The level data are presented graphically in Fig. 2.20.2.

2.20.4 Supplemental Information

Most of the contents of Tank W-8 were removed during the 1982 sludge removal effort. Current readings indicate that the volume is approximately 50,040 gal. This indicates that the level has been increasing for the past several years. The liquids entering the tank are believed to result from infiltration from runoff or groundwater. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.20.1. Schematic of Tank W-8.

Fig. 2.20.2. Tank W-8 level data.

2.21 TANK W-9

2.21.1 Tank Level Trend Analysis Summary

During a period of 92 days from August 1, 1993 through October 31, 1993, the calculated mean level trend was 0.10 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.21.2 Tank and Level Monitoring Equipment Description

Tank W-9, located in the South Tank Farm in the main plant area of ORNL, is a vertical Gunitite™ tank with a 170,000-gal capacity and as of December 1993 an estimated residual waste volume of 36,887 gal. Inflow from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.21.1.

2.21.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 0.10 gpd (increasing) and 0.17 gpd respectively. The 95% upper confidence limit is 0.42 gpd, and the 95% lower confidence limit is -0.23 gpd. No definitive level trend can be established on the basis of the collected data. The level data are presented graphically in Fig. 2.21.2.

2.21.4 Supplemental Information

Most of the contents of Tank W-9 were removed during the 1982 sludge removal effort. Current readings indicate that the volume is approximately 36,887 gal. This indicates that the level has been increasing for the past several years.

The liquids entering the tank are believed to result from infiltration from surface runoff or groundwater. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.21.1. Schematic of Tank W-9.

Fig. 2.21.2. Tank W-9 level data.

2.22 TANK W-10

2.22.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean decreasing level trend was -3.02 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.22.2 Tank and Level Monitoring Equipment Description

Tank W-10, located in the South Tank Farm in the main plant area of ORNL, is a vertical GunitTM tank with a 170,000-gal capacity and as of December 1993 an estimated residual waste volume of 98,890 gal. Inflow from process sources was stopped in 1980 when the tank was removed from service.

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and are manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.22.1.

2.22.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as -3.02 gpd (decreasing) and 0.39 gpd, respectively. The 95% upper confidence limit is -2.25 gpd. The downward level trend has a 95% probability of being greater than or equal to -2.25 gpd based on the collected data. The level data are presented graphically in Fig. 2.22.2.

2.22.4 Supplemental Information

Tank W-10 was used as the final staging tank during the 1982 sludge removal effort and was not emptied due to lack of funding.

The liquids entering the tank are believed to result from infiltration from surface runoff or groundwater. Several penetrations were made in the top of tanks in the South Tank Farm to facilitate sludge removal. Infiltration can enter through these penetrations to the tank.

Fig. 2.22.1. Schematic of Tank W-10.

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Fig. 2.222. Tank W-10 level data.

2.23 TANK W-11

2.23.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean level trend was 0.01 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.23.2 Tank and Level Monitoring Equipment Description

Tank W-11, located in the southeast of the South Tank Farm in the main plant area of ORNL, is a vertical Gunite™ tank with a 1500-gal capacity and as of December 1993 an estimated residual waste volume of approximately 744 gal. Inflow from process sources was stopped in 1948 when the tank was removed from service.

The liquid level is monitored with a float and staff gage. The gage measures level through the use of a float that follows the liquid motion vertically. A staff attached to the float extends to the surface, where the motion of the float and staff can be observed. The staff is equipped with a pointer that indicates the relative motion of the liquid in inches on a graduated, vertically mounted rule. The vertical motion is recorded daily on a log sheet and is manually converted to volume in the tank. A schematic drawing of the tank is shown in Fig. 2.23.1.

2.23.3 Results of Level Trend Analysis

During the 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as 0.01 gpd and 0.05 gpd, respectively. The 95% upper confidence limit is 0.11 gpd, and the 95% lower confidence limit is -0.08 gpd. No definitive level trend can be established on the basis of the collected data. The level data are presented graphically in Fig. 2.23.2.

2.23.4 Supplemental Information

Tank W-11 receives infiltration from surface runoff or groundwater that is periodically removed.

Fig. 2.23.1. Schematic of Tank W-11.

ORNL-DWG 94-2084

Tank W-11

Fig. 2.23.2. Tank W-11 level data.

2.24 TANK W-13

2.24.1 Tank Level Trend Analysis Summary

Tank W-13 is empty: therefore, no level trend analysis will be performed on the tank.

2.24.2 Standards for Level Trend Analysis

Not applicable.

2.24.3 Supplemental Information

Tank W-13, located in the North Tank Farm in the main plant area of ORNL, is a horizontal, stainless steel tank with a 2000-gal capacity. There is no known inflow or outflow. The liquid level is not monitored. A schematic drawing of the tank is shown in Fig. 2.24.1.

No leaks have been reported from Tank W-13. The tank is mounted on a sloped, concrete slab that drains to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.24.1. Schematic of Tank W-13.

2.25 TANK W-14

2.25.1 Tank Level Trend Analysis Summary

Tank W-14 is empty: therefore, no level trend analysis will be performed on the tank.

2.25.2 Standards for Level Trend Analysis

Not applicable.

2.25.3 Supplemental Information

Tank W-14, located in the North Tank Farm in the main plant area of ORNL, is a horizontal, stainless steel tank with a 2000-gal capacity. There is no known inflow or outflow. The liquid level is not monitored. A schematic drawing of the tank is shown in Fig. 2.25.1.

No leaks have been reported from Tank W-14. The tank is mounted on a sloped, concrete slab that drains to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.25.1. Schematic of Tank W-14.

2.26 TANK W-15

2.26.1 Tank Level Trend Analysis Summary

Tank W-15 is empty; therefore, no level trend analysis will be performed on the tank.

2.26.2 Standards for Level Trend Analysis

Not applicable.

2.26.3 Supplemental Information

Tank W-15, located in the North Tank Farm in the main plant area of ORNL, is a vertical, stainless steel tank with a 2000-gal capacity. There is no known inflow or outflow. The liquid level is not monitored. A schematic drawing of the tank is shown Fig. 2.26.1.

No leaks have been reported from Tank W-15. The tank is mounted on a sloped, concrete slab that drains to a dry well. The dry well is periodically monitored to determine the level of radioactivity; elevated readings would indicate a possible leak. No elevated readings in the dry well have been noted to date.

Fig. 2.26.1. Schematic of Tank W-15.

2.27 TANK W-19

2.27.1 Tank Level Trend Analysis

Tank W-19 is empty; therefore, no level trend analysis will be performed on the tank.

2.27.2 Standards for Level Trend Analysis

Not applicable.

2.27.3 Supplemental Information

Tank W-19, located south of the South Tank Farm of ORNL, is a vertical, stainless steel tank with a 2250-gal capacity. The tank was removed from service in the 1960s and was reported to be empty when last sampled in 1990. The tank is being monitored. There is no known inflow to the tank; therefore, the tank is expected to remain empty. A schematic drawing of the tank is shown in Fig. 2.27.1.

No leaks were reported during the service life of the tank.

Fig. 2.27.1 Schematic of Tank W-19

2.28 TANK W-20

2.28.1 Tank Level Trend Analysis Summary

Tank W-20 is empty; therefore, no level trend analysis will be performed on the tank.

2.28.2 Standards for Level Trend Analysis

Not applicable.

2.28.3 Supplemental Information

Tank W-20, located south of the South Tank Farm of ORNL, is a vertical, stainless steel tank with a 2250-gal capacity. The tank was removed from service in the 1960s and was reported to be empty when last sampled in 1989. The tank is being monitored. There is no known inflow to the tank; therefore, the tank is expected to remain empty. A schematic drawing of the tank is shown in Fig. 2.28.1.

No leaks were reported during the service life of the tank.

Fig. 2.28.1. Schematic of Tank W-20.

2.29 TANK WC-1

2.29.1 Tank Level Trend Analysis Summary

Tank WC-1 is empty; therefore, no level trend analysis will be performed on the tank.

2.29.2 Standards for Level Trend Analysis

Not applicable.

2.29.3 Supplemental Information

Tank WC-1, located east of Building 3038 in the main plant area of ORNL, is a vertical, stainless steel tank with a 2150-gal capacity and a residual volume of ~375 gal with no sludge. There is no known process inflow or outflow. A schematic drawing of the tank is shown in Fig. 2.29.1.

The discharge lines exiting at the top of the tank were reported as leaking, and the tank was removed from service.

Fig. 2.29.1. Schematic of Tank WC-1.

2.30 TANK WC-15

2.30.1 Tank Level Trend Analysis Summary

During the 72 days from August 21, 1993 through October 31, 1993, the calculated mean decreasing level trend was -0.30 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.30.2 Tank and Level Monitoring Equipment Description

Tank WC-15, located south of Building 3587 in the main plant area of ORNL, is a vertical, stainless steel tank with a 1000 gallon capacity and as of December 1993 an estimated residual waste volume of 443 gal. There is no known process inflow or outflow, although infiltration of surface and/or groundwater has been confirmed because the tank was emptied when removed from service and was later reported full (DOE/OR/01-1138&D1).

The liquid level is monitored with a conductivity probe gage. The instrument measures level by lowering a conductivity probe suspended on a tape. When the probe reaches the liquid, the tape stops and the length of tape is automatically recorded. The volume is calculated by the instrument based on the reference level, length of tape dispensed, and tank geometry programmed into the instrument. Level readings are displayed in gallons and manually recorded daily on a log sheet. A schematic drawing of the tank is shown in Fig. 2.30.1.

2.30.3 Results of Level Trend Analysis

The level trend was calculated during 72 days from August 21 to October 31, 1993. Measurements indicated a slight decrease in level over this period. The mean level trend and standard error were calculated at -0.31 gpd and 0.03 gpd, respectively. The 95% upper confidence limit is -0.24 gpd. The downward level trend has a 95% probability of being greater than or equal to -0.24 gpd based on the collected data. The level data are presented graphically in Fig. 2.30.2.

2.30.4 Supplemental Information

The tank was reported as leaking and was removed from service in the 1960s. Review of level trend data in August indicated a marked downward change in the level during early August, 1993, and action was initiated to investigate the tank and the instrumentation. A remote video inspection was performed inside the tank as part of the investigation and it was determined that holes in the bottom of the tank were allowing direct communication with the local water table. The liquid contents

Fig. 2.30.1. Schematic of Tank WC-15.

Fig. 230.2. Tank WC-15 level data.

were immediately removed. The level trend stabilized on August 21, and the trend data is plotted starting from that date; the trend is believed to be reflective of the trend of the local water table around the tank (M. L. Whitehead, August 1993).

2.30.5 References

H&R Technical Associates, Inc. March 1993 , *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

2.31 TANK WC-17

2.31.1 Tank Level Trend Analysis Summary

During the 92 days from August 1, 1993 through October 31, 1993, the calculated mean decreasing level trend was -0.11 gpd. This level trend is valid for the period evaluated but can vary significantly during other periods as a result of changes in precipitation, groundwater level, and other environmental factors that can influence the rate of infiltration.

2.31.2 Tank and Level Monitoring Equipment Description

Tank WC-17, located south of Building 3587 in the main plant area of ORNL, is a vertical, stainless steel tank with a 1000-gal capacity and a residual volume of approximately 426 gal. There is no known inflow or outflow except for the groundwater condition noted in Sect. 2.31.4. The liquid level is monitored with a pneumatic gage system maintained by ORNL. Level change is reflected by a gage that indicates percentage of volume, which is converted to volume in gal using a conversion table. A schematic drawing of the tank is shown in Fig. 2.31.1.

2.31.3 Results of Level Trend Analysis

During 92 days from August 1 to October 31, 1993, the mean level trend and standard error were calculated as -0.11 gpd (decreasing) and 0.05 gpd, respectively. The 95% upper confidence limit is -0.02 gpd. The downward level trend has a 95% probability of being greater than or equal to -0.02 gpd based on the collected data. The level data are presented graphically in Fig. 2.31.2.

2.31.4 Supplemental Information

In December, 1992 Tank WC-17 was emptied and rinsed three times. A video inspection of the tank indicated two holes in the bottom of the tank, which allow groundwater to enter the tank (DOE/OR/01-1138&D1). The liquid level in this tank

Fig. 2.31.1. Schematic of Tank WC-17.

Fig. 2.31.2. Tank WC-17 level data.

will therefore move upward and downward with the local water table around the tank, except for possible surface water infiltration during periods of high precipitation.

2.31.5 References

H&R Technical Associates, Inc. March 1993 , *Remediation Schedule for Inactive Liquid Low-Level Waste Storage Tanks at ORNL*, DOE/OR/01-1138&D1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

2.32 TANK 3001-B

2.32.1 Tank Level Trend Analysis Summary

Tank 3001-B is empty; therefore no level trend analysis will be performed on the tank.

2.32.2 Standards for Level Trend Analysis

Not applicable.

2.32.3 Supplemental Information

Tank 3001-B, located south of Building 3001 in the main plant area of ORNL, has an estimated capacity of 50-100 gal. The tank was removed from service in the 1960s. There is no known inflow into the tank; therefore the tank is expected to remain empty.

No service information is available.

2.33 TANK 3003-A

2.33.1 Tank Level Trend Analysis Summary

Tank 3003-A has been emptied and is being monitored; therefore no level trend analysis will be performed on the tank.

2.33.2 Standards for Level Trend Analysis

Not applicable.

2.33.3 Supplemental Information

Tank 3003-A, located south of Building 3003 in the main plant area of ORNL, is constructed of concrete and has a capacity of approximately 16,000 gal.

The tank was removed from service in 1965.

2.34 TANK 3004-B

2.34.1 Tank Level Trend Analysis Summary

Tank 3004-B has been emptied and is being monitored; therefore no level trend analysis will be performed on the tank.

2.34.2 Standards for Level Trend Analysis

Not applicable.

2.34.3 Supplemental Information

Tank 3004-B, located east of Building 3008 in the main plant area of ORNL, is constructed of stainless steel and has a capacity of 30 gal.

No service information is available.

2.35 TANK 3013

2.35.1 Tank Level Trend Analysis Summary

Tank 3013 has been emptied and is being monitored; therefore no level trend analysis will be performed on the tank.

2.35.2 Standards for Level Trend Analysis

Not applicable.

2.35.3 Supplemental Information

Tank 3013, located at the southwest corner of Building 3008 in the main plant area of ORNL, is a vertical, stainless steel tank with a 350-gal capacity.

No service information is available.

2.36 TANK 7503A

2.36.1 Tank Level Trend Analysis Summary

Tank 7503A is empty; therefore no level trend analysis will be performed on the tank.

2.36.2 Standards for Level Trend Analysis

Not applicable.

2.36.3 Supplemental Information

Tank 7503A, located inside Building 7503 at the Molten Salt Reactor Experiment Facility, is constructed of stainless steel and has a capacity of 11,000 gal.

No service information is available.

2.37 TANK 7560

2.37.1 Tank Level Trend Analysis Summary

Tank 7560 is empty; therefore, no level trend analysis will be performed on the tank.

2.37.2 Standards for Level Trend Analysis

Not applicable.

2.37.3 Supplemental Information

Tank 7560, located east of Building 7500 in the Homogeneous Reactor Experiment Area of ORNL, is a horizontal, stainless steel tank with a 1000-gal capacity. The tank is located underground and served as a waste tank for Building 7500. There is no known inflow or outflow. A schematic drawing of the tank is shown in Fig. 2.37.1.

No leaks have been reported from the tank during its service life. The tank was emptied when removed from service in 1961.

Fig. 2.37.1. Schematic of Tank 7560.

2.38 TANK 7562

2.38.1 Tank Level Trend Analysis Summary

The level monitor on Tank 7562 has been found defective. No valid data is available for analysis at this time.

2.38.2 Standards for Level Trend Analysis

Not applicable.

2.38.3 Supplemental Information

Tank 7562, located southeast of Building 7500 in the Homogeneous Reactor Experiment Area of ORNL, is a horizontal, stainless steel tank with a 12,000-gal capacity. A schematic drawing of the tank is shown in Fig. 2.38.1.

Tank 7562 is being evaluated to determine if all inputs have been terminated. The level monitoring instrument is being investigated and repaired, and a level trend analysis will be performed on this tank as soon as a minimum of 30 consecutive days of consistent data is recorded.

Fig. 2.38.1. Schematic of Tank 7562.

Appendix A

LEVEL TREND ANALYSIS APPROACH

LEVEL TREND ANALYSIS APPROACH

INTRODUCTION

The following paragraphs describe the approach developed for level trend analysis of level monitoring data collected for the inactive LLLW tanks at ORNL. The analysis is designed to identify long-term trends that reflect general increase or decrease in level. A low level of precision (5% of the tank volume) is acceptable for collecting data as an input for this analysis. The inactive LLLW tanks are not in service and are being monitored as part of a continuing surveillance and maintenance program until they have been remediated. If changes in level trends occur, the tanks and monitoring equipment are investigated to determine the cause.

ANALYSIS APPROACH

This statistical approach uses existing equipment regardless of the type because of the low precision required. Tanks that do not have level monitors will have monitors installed if level trend analysis is to be performed.

The objective of the level trend analysis is to determine whether the liquid level in the tank is increasing or decreasing during the period evaluated and to provide an estimate of the rate of change (i.e., the liquid level trend in gallons per day). The trend analysis was performed using linear regression to generate a straight-line estimate of the collected data. The slope of the line represents the liquid level trend.

The statistical nature of the evaluation assumes that a mathematical variation in the estimated slope of the line exists termed "the standard error of the slope estimate." This error was calculated for each data set. From the standard error, the slope of the line was calculated at the 95% confidence boundaries using the "Student T" distribution. The objective was to produce results that indicated a 95% confidence that the slope of the line was positive (i.e., increasing in liquid level) or negative (i.e., decreasing in liquid level).

A period of 90 days was evaluated. The slope of the regression line and the 95% confidence boundaries for the slope were calculated. If the upper and lower 95% confidence boundaries were both positive or both negative, then the results of the level trend analysis reflect a 95% confidence that the direction of the trend has been determined. If the upper 95% confidence boundary was positive and the lower boundary was negative, the results were considered inconclusive. This result can occur when the level monitoring system (equipment and methods) causes scattered data points to be collected. An example calculation is included at the end of this Appendix.

Data were selected from the period August 1, 1993, through October 31, 1993. These were the latest data available when the evaluation was performed.

LIMITATIONS

Level trend analysis provides an estimate of the trend for only the period evaluated. A period of 90 days was selected as a starting point to provide sufficient time and data points for the analysis. The longer the period evaluated, the more the results are influenced by environmentally induced error, instrument error, and other recurring interruptions. The shorter the time period, the less the results are influenced by the above factors. However, shorter durations of trend analysis reduce the sensitivity of the analysis, and the results may not reflect the direction of the trend at 95% confidence.

The trend analysis indicates a net increase or decrease in the liquid level. Absolute increase or decrease cannot be measured unless the tank is isolated from infiltration of rainwater into the connecting lines and/or through roof penetrations in the tank.

The data used for the analysis are from existing level monitoring equipment and were collected using existing procedures. The equipment and procedures were not designed nor approved for use as a leak detection system. The level monitoring instruments and their associated sensitivity (the smallest measurement that can be reliably made) varies greatly between instrument types and design. These factors may influence the quality of the data, resulting in analyses which generate inaccurate conclusions.

ASSUMPTIONS

In performing the level trend analyses the following are assumed:

- The level measurement approach uses existing equipment regardless of type. Tanks that do not have level monitors will have monitoring equipment installed if level trend analysis is to be performed.
- The instruments are maintained in operable condition.
- The data have been collected with reasonable diligence.
- The evaluation is relatively insensitive to random error because of the statistical nature of the evaluation.

- The trend analysis indicates a net increase or decrease in the liquid level. Absolute increase or decrease cannot be measured unless the tank is isolated from infiltration of rainwater and/or groundwater into the connecting lines and/or through roof penetrations in the tank.

The approach for calculating the leak rate is to perform linear regression analysis on liquid level monitoring data for a minimum of 30 days. The line has the form of

$$y = a + bx$$

Where x is the independent variable, time in days; y is the dependent variable, tank volume in gallons; a is the y-axis intercept at time x = 0; and b is the slope of the regression line. The slope of the line "b" represents the average rate of change in gallons per day.

$$b = SS_{xy}/SS_{xx}$$

where,

$$SS_{xy} = \Sigma(X_{\text{mean}} - X)(Y_{\text{mean}} - Y)$$

$$SS_{xx} = \Sigma(X_{\text{mean}} - X)^2$$

$$SS_{yy} = \Sigma(Y_{\text{mean}} - Y)^2$$

$$X_{\text{mean}} = \Sigma X/n$$

$$Y_{\text{mean}} = \Sigma Y/n$$

$$n = \text{number of observations}$$

The fit of the line to the data is a least squares fit and is subject to error. The measure of this error is the standard error, S_b . S_b is defined as follows:

where,

$$S_b = Syx/\sqrt{SS_{xx}}$$

$$Syx = \text{the standard deviation}$$

$$Syx = \pm \sqrt{(SS_{yy} - SS_{xy}^2/SS_{xx}) / (n-2)}$$

Substituting S_{yx} in the equation for S_b results in:

$$S_b = \frac{\sqrt{[SS_{yy} - (SS_{xy})(SS_{xy})/SS_{xx}]}}{\sqrt{(n-2)(SS_{xx})}}$$

EXAMPLE CALCULATION

X	DATE (1990)	Y	Syy= Ymean-Y	Sxx= Xmean-X	Sxx x Syy	Square e of Sxx	Square of Syy
1	01-Sep	38814	15.2	14.5	220.4	210.25	231.04
2	02-Sep	38826	3.2	13.5	43.2	182.25	10.24
3	03-Sep	38802	27.2	12.5	340.0	156.25	739.84
4	04-Sep	38846	-16.8	11.5	-193.2	132.25	282.24
5	05-Sep	38827	2.2	10.5	23.1	110.25	4.84
6	06-Sep	38812	17.2	9.5	163.4	90.25	295.84
7	07-Sep	38822	7.2	8.5	61.2	72.25	51.84
8	08-Sep	38787	42.2	7.5	316.5	56.25	1780.84
9	09-Sep	38807	22.2	6.5	144.3	42.25	492.84
10	10-Sep	38802	27.2	5.5	149.6	30.25	739.84
11	11-Sep	38836	-6.8	4.5	-30.6	20.25	46.24
12	12-Sep	38825	4.2	3.5	14.7	12.25	17.64
13	13-Sep	38817	12.2	2.5	30.5	6.25	148.84
14	14-Sep	38820	9.2	1.5	13.8	2.25	84.64
15	15-Sep	38800	29.2	0.5	14.6	0.25	852.64
16	16-Sep	38908	-78.8	-0.5	39.4	0.25	6209.44
17	17-Sep	38861	-31.8	-1.5	47.7	2.25	1011.24
18	18-Sep	38881	-51.8	-2.5	129.5	6.25	2683.24
19	19-Sep	38797	32.2	-3.5	-112.7	12.25	1036.84
20	20-Sep	38861	-31.8	-4.5	143.1	20.25	1011.24
21	21-Sep	38838	-8.8	-5.5	48.4	30.25	77.44
22	22-Sep	38861	-31.8	-6.5	206.7	42.25	1011.24
23	23-Sep	38836	-6.8	-7.5	51.0	56.25	46.24
24	24-Sep	38817	12.2	-8.5	-103.7	72.25	148.84
25	25-Sep	38841	-11.8	-9.5	112.1	90.25	139.24
26	26-Sep	38822	7.2	-10.5	-75.6	110.25	51.84
27	27-Sep	38831	-1.8	-11.5	20.7	132.25	3.24
28	28-Sep	38826	3.2	-12.5	-40.0	156.25	10.24
29	29-Sep	38812	17.2	-13.5	-232.2	182.25	295.84
30	30-Sep	38841	-11.8	-14.5	171.1	210.25	139.24
Sum of X =		Sum of Y =			SSxy =	Sxx =	SSyy =
465		1164876			Sums = 1717.0	2247.5	19654.8
Xmean = 15.5		Y mean =					
		38829.2					

$$\text{X Coefficient} = \frac{SS_{xy}}{SS_{xx}}$$

$$\text{X Coefficient} = \frac{1717.0}{2247.5} = 0.76396$$

$$\text{Standard Error of Coefficient} = \text{SQRT of } \frac{SS_{yy} - (SS_{xy})(SS_{xy})/SS_{xx}}{(n-2)(SS_{xx})}$$

$$= \text{SQRT of } \frac{19654.8 - (1717)(1717)/2247.5}{(30-2)(2247.5)}$$

$$= 0.53989$$

$$\text{95\% Confidence Interval} = \text{X coefficient } \pm t_{(0.025)} (\text{Standard Error of Coefficient})$$

$$= 0.76396 - 2.04 \times 0.53989 \text{ lower bound}$$

$$+ 2.04 \times 0.53989 \text{ upper bound}$$

$$= -0.337 \text{ lower bound (gal/d)}$$

$$+1.865 \text{ upper bound (gal/d)}$$

Figure A.1 presents a plot of the data and the calculated linear regression line.

Fig. A.1

Figure A.1 presents a plot of the data and the calculated linear regression line.

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