System Logic Description for Analytical Laboratory - Radioactive Liquid Waste (RLD) System

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History Sheet

Rev	Reason for revision	Revised by
0	Issued for Permitting Use	A. Pfeif
1	Revised to include changes to permitted instruments	N. A. Gergely
2	**Revised to include changes to sump leak alarms**	**M. D. Dingeldein**

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Acronyms

AEA	Atomic Energy Act
DOE	US Department of Energy
DWP	Dangerous Waste Permit
LAB	analytical laboratory
LAH	level alarm high
LAHH	level alarm high high
LAL	level alarm low
LI	level indicator
LKY	**level rate of change calculation**
LSH	level switch high
LT	level transmitter
P&ID	piping and instrumentation diagram
RLD	radioactive liquid waste disposal
WTP	Hanford Tank Waste Treatment and Immobilization Plant

Glossary

acquire	Acquire is a command under batch control that reserves a group of equipment for a particular batch control operation.
batch	Batch is the material that is being produced or that has been produced by a single execution of a batch process.
batch control	Batch control refers to control activities and control functions that provide an ordered set of processing activities to complete a batch process.
batch process	A batch process is a process that leads to the production of finite quantities of material by subjecting quantities of input materials to an ordered set of processing activities over a finite period of time using one or more pieces of equipment.
control system	Refers to electronic processors that perform regulatory and logical control functions necessary for normal plant operation
exception handling	Exception handling refers to those functions that deal with plant or process contingencies and other events that occur outside the normal or desired behavior of batch control.
level alarm high (LAH)	A vessel high-level setpoint used to stop a transfer-in batch operation to a vessel under normal plant operation.
level alarm high high (LAHH)	Refers to a notification in the control system that is activated when the applicable variable reaches a point that is significantly higher than that expected during normal operation
level alarm low (LAL)	A vessel low-level set point used to stop a transfer-out batch operation from a vessel under normal plant operations.
release	Release is a command under batch control that opens up a group of equipment for any batch control to acquire.

1 Introduction

This document describes the instrument control logic for Dangerous Waste Permit (DWP) tank and ancillary equipment in the radioactive liquid waste disposal (RLD) system within the analytical laboratory (LAB) associated with dangerous waste management. **This document has been prepared as one of the documents that have been or will be developed to provide tank, ancillary equipment, and leak detection system instrument control logic narrative description (e.g., software functional specifications, descriptions of fail-safe conditions, etc.) to meet the requirements of permit condition III.10.E.9.d.vii;**

2 Applicable Documents

24590-WTP-M6-50-00001	*P&ID Symbols and Legend Sheet 1 of 8*
24590-WTP-M6-50-00002	*P&ID Symbols and Legend Sheet 2 of 8*
24590-WTP-M6-50-00003	*P&ID Symbols and Legend Sheet 3 of 8*
24590-WTP-M6-50-00004	*P&ID Symbols and Legend Sheet 4 of 8*
24590-WTP-M6-50-00005	*P&ID Symbols and Legend Sheet 5 of 8*
24590-WTP-M6-50-00006	*P&ID Symbols and Legend Sheet 6 of 8*
24590-WTP-M6-50-00007	*P&ID Symbols and Legend Sheet 7 of 8*
24590-WTP-M6-50-00008	*P&ID Symbols and Legend Sheet 8 of 8*
24590-LAB-M6-RLD-00001001	***P&ID - LAB Radioactive Liquid Waste Disposal System C5 Collection and Transfer RLD-VSL-00165***
24590-LAB-M6-RLD-00001002	***P&ID - LAB Radioactive Liquid Waste Disposal System C5 Collection and Transfer RLD-PMP-00183A***
24590-LAB-M6-RLD-00001003	***P&ID - LAB Radioactive Liquid Waste Disposal System C5 Collection and Transfer RLD-PMP-00183B***
24590-LAB-M6-RLD-00001004	***P&ID - LAB Radioactive Liquid Waste Disposal System C5 Collection and Transfer Valve Pit***
24590-LAB-M6-RLD-00002001	***P&ID - LAB Radioactive Liquid Waste Disposal System C3 Collection & Transfer RLD-VSL-00164***
24590-LAB-M6-RLD-00002003	***P&ID - LAB Radioactive Liquid Waste Disposal System C3 Collection & Transfer RLD-PMP-00182A/B***
24590-LAB-M6-RLD-00006001	***P&ID - LAB Radioactive Liquid Waste Disposal System C3 RAD LAB Collection***

24590-LAB-M6-RLD-00006002	*P&ID - LAB Radioactive Liquid Waste Disposal System C3 RAD LAB Collection*
24590-LAB-M6-RLD-00006003	*P&ID - LAB Radioactive Liquid Waste Disposal System C3 RAD LAB Collection*
24590-LAB-M6-RLD-00007001	*P&ID - LAB Radioactive Liquid Waste Disposal System C3 Leak Detection Boxes*
24590-LAB-M6-RLD-00007002	*P&ID - LAB Radioactive Liquid Waste Disposal System C3 Collection Drain Header*
24590-LAB-M6-RLD-00008001	*P&ID - LAB Radioactive Liquid Waste Disposal System - C5 Leak Detection Boxes*
24590-LAB-M6-RLD-00008002	*P&ID - LAB Radioactive Liquid Waste Disposal System C5 Drain Collection Headers*
24590-LAB-3YD-RLD-00001	*System Description for the Analytical Laboratory Radioactive Liquid Waste Disposal System (RLD)*

3 Description

The DWP tank and ancillary equipment associated with dangerous waste management within the RLD system are the following:

- RLD-VSL-00165 Hotcell drain collection vessel (C5 vessel)
- **RLD-VSL-00164 Lab area sink drain collection vessel (C3 vessel)**
- RLD-PMP-00183A Hotcell drain collection vessel pump (C5 vessel)
- RLD-PMP-00183B Hotcell drain collection vessel pump (C5 vessel)
- RLD-PMP-00182A Lab area sink drain collection vessel pump (C3 vessel)
- RLD-PMP-00182B Lab area sink drain collection vessel pump (C3 vessel)
- **RLD-SUMP-00042 C5 vessel cell sump**
- RLD-SUMP-00041 C3 vessel cell pump
- RLD-SUMP-00043A C5 pump pit sump
- RLD-SUMP-00043B C5 pump pit sump
- RLD-SUMP-00044 C5 piping pit sump
- RLD-SUMP-00045 C3 pump pit sump
- RLD-LDB-00002 Hotcell collection leak detection box
- RLD-LDB-00004 C3 transfer leak detection box
- RLD-LDB-00005 RAD Lab sink collection header leak detection box
- RLD-LDB-00006 PVA drain header leak detection box
- RLD-LDB-00007 C3 maintenance drain header leak detection box
- RLD-LDB-00008 Sample receive/send drain header leak detection box
- RLD-LDB-00009 Glovebox header leak detection box
- RLD-LDB-00011 ASX equipment drain collection header leak detection box

Note: The Floor Drain Collection Vessel (RLD-VSL-00163) collects, contains, and transfers non-contaminated liquid effluent. Although the floor drain collection vessel is identified as part of the RLD system, it is not designed or permitted to manage mixed or dangerous wastes.

3.1 Hotcell Drain Collection Vessel

The hotcell drain collection vessel (RLD-VSL-00165) receives effluent from hotcell glovebox drains, hotcell cupsinks, hotcell transfer drawers, the master-slave manipulator decontamination glovebox, hotcell sample drop station, and the hotcell drain collection vessel pump pits and valve pit sumps. Effluents from the lab area sink drain collection vessel (RLD-VSL-00164) and the floor drain collection vessel (RLD-VSL-00163) can also be transferred to the hotcell drain collection vessel (RLD-VSL-00165). For waste management reliability, batch controlled transfers into RLD-VSL-00165 are limited by the control system to one transfer in or out at a time by the batch control mechanism of acquiring and releasing. Once acquired, no other batch control operation will be able to coordinate activities with the hotcell drain collection vessel (RLD-VSL-00165) until it is released.

When the vessel is available to receive effluent, the operator will initiate the transfer-in sequence. Once the sequence is initiated, the control system will verify that instruments, utilities, and equipment associated with the transfer are within operational parameters. If any of the monitored parameters are not within the specified limits during the transfer, the control system will switch to exception handling logic that will return the equipment associated with the transfer to a safe state. During normal operation, the batch transfer sequence is stopped by the control system when any of the following **conditions are met**:

- The level in the hotcell drain collection vessel (RLD-VSL-00165) reaches its level alarm high (LAH)
- The level of the sending equipment reaches its level alarm low (LAL).

When the LAH of the hotcell drain collection vessel (RLD-VSL-00165) is reached, the control system will notify an operator through the plant control system interface that the hotcell drain collection vessel (RLD-VSL-00165) is ready to transfer its contents. The operator will then initiate the transfer-out sequence within the control system. Once initiated, the control system verifies that instruments, utilities, and equipment associated with the transfer are within operational parameters and remain as such throughout the transfer. If any of the monitored parameters are not within the specified limits during the transfer, the control system will switch to exception handling logic that will return the equipment associated with the transfer to a safe state. During normal operation, the batch transfer sequence will end when any of the following **conditions are met**:

- The level in the hotcell drain collection vessel (RLD-VSL-00165) reaches its LAL
- The level of the receiving vessel reaches its LAH. During routine operations, pretreatment plant wash vessel, PWD-VSL-00044 or the pretreatment ultimate overflow vessel, PWD-VSL-00033, receive transfer line flushes.

When the level is **above** the normal operating range due to an abnormality, interlocks and alarms within the control system help prevent an overflow condition. Figure 1 shows the interlocks and alarms for the level instrument associated with the hotcell drain collection vessel (RLD-VSL-00165). At the **high** high-alarm setpoint, an alarm **(LAHH)** is generated and all dedicated controlled feeds are isolated. Isolation occurs by stopping the motive force, closing valves, or a combination of both.

3.2 Radiological Laboratory Area Sink Drain Collection Vessel

The radiological laboratory (referred to in this document as the lab) area sink drain collection vessel (RLD-VSL-00164) receives effluent from the lab sinks, the lab fume hood sinks, decontamination showers and sinks, autosampling system equipment drains, the receiving and shipping area, process vacuum equipment, other floor drains throughout the LAB, and the C3 pump pit sump (RLD-SUMP-00045). Effluents from the floor drain collection vessel (RLD-VSL-00163) can also be transferred to the lab area sink drain collection vessel (RLD-VSL-00164). **Batch** controlled transfers into RLD-VSL-00164 are limited by the control system to one transfer in or out at a time by the batch control mechanism of acquiring and releasing. Once acquired, no other batch control operation will be able to coordinate activities with the lab area sink drain collection vessel (RLD-VSL-00164) until it is released.

When the vessel is available to receive effluent, the operator will initiate the transfer-in sequence. Once the sequence is initiated, the control system will verify that instruments, utilities, and equipment associated with the transfer are within operational parameters. If any of the monitored parameters are not within the specified limits during the transfer, the control system will switch to exception handling logic that will return the equipment associated with the transfer to a safe state. During normal operation, the batch transfer sequence is stopped by the control system when any of the following **conditions are met**:

- The level in the lab area sink drain collection vessel (RLD-VSL-00164) reaches its LAH
- The level of the sending **vessel** reaches its LAL

When the LAH of the lab area sink drain collection vessel (RLD-VSL-00164) is reached, the control system will notify an operator through the plant control system interface that the lab area sink drain collection vessel is ready to transfer its contents. The operator will then initiate the transfer-out sequence within the control system. Once initiated, the control system verifies that instruments, utilities, and equipment associated with the transfer are within operational parameters and remain as such throughout the transfer. If any of the monitored parameters are not within the specified limits during the transfer, the control system will switch to exception handling logic that will return the equipment associated with the transfer to a safe state. During normal operation, the batch transfer sequence will end when any of the following **conditions are met**:

- The level in the lab area sink drain collection vessel (RLD-VSL-00164) reaches its LAL
- The level of the receiving equipment reaches its LAH.

When the level is **above** the normal operating range due to an abnormality, interlocks along with alarms within the control system help prevent an overflow condition. Figure 1 shows the interlocks and alarms for the level instrument associated with the lab area sink drain collection vessel (RLD-VSL-00164). At the **high** high-alarm setpoint, an alarm **(LAHH)** is generated and all dedicated controlled feeds are isolated. Isolation occurs by stopping the motive force, closing valves, or a combination of both.

3.3 Cell and Equipment Sumps

The LAB has two different types of sumps: **vessel cell sumps and** pump or piping pit sumps. The hotcell drain collection vessel (RLD-VSL-00165) and the lab area sink drain collection vessel (RLD-VSL-00164) have their own set of sumps. The sumps for the hotcell drain collection vessel (RLD-VSL-00165) are the C5 vessel cell sump (RLD-SUMP-00042), the C5 pump pit sumps (RLD-SUMP-00043A and

RLD-SUMP-00043B), and the C5 piping pit sump (RLD-SUMP-00044). In the event of a level detection in the C5 vessel cell sump, the operator routes the liquid to the pretreatment plant wash vessel (PWD-VSL-00044).

The sumps for the lab area sink drain collection vessel (RLD-VSL-00164) are the C3 vessel cell sump (RLD-SUMP-00041) and the C3 pump pit sump (RLD-SUMP-00045). In the event of a level detection in the C3 vessel cell sump, the operator routes the liquid to the hotcell drain collection vessel (RLD-VSL-00165). **A general description of radar level detection in sumps can be found in Section 3.2.1 of *Leak Detection in Secondary Containment Systems* (24590-WTP-PER-J-02-002). In the event of a level detection alarm, the source of the spill will be identified and isolated, and notifications, spill response and waste removal will be completed in accordance with WTP Operating and Spill Response procedures.**

3.3.1 Vessel Cell Sumps

Lab vessel cell sumps start out dry, and typically will remain dry, but can receive liquids during normal or off-normal operations. A sump leak detection alarm can result from vessel cell decontamination flushes, a vessel or piping leak in the vessel cell, or fire water from C3/C5 sprinkler system that flows into the vessel causing the vessel to overflow into the cell sump. Sump liquids from normal operations will typically include decontamination flushes of vessel cells. Sump liquids from off-normal operations include spills (vessel overflow) or leaks from vessels, piping, or pumps. Identification of the source of the sump liquids is a DWP requirement that stipulates that the operator determine the source of a spill or leak, determine if the sump liquid is a dangerous waste, and determine where the liquids will be transferred.

Figure 2 shows the alarms for the level instrument associated with the C5 vessel cell sump (RLD-SUMP-00042), which also serves as a typical method of operation for the C3 vessel cell sump (RLD-SUMP-00041). These level instruments have three alarm points to meet leak detection requirements. The first alarm point assumes that the sump is completely dry. The first alarm point alerts the operator when the fluid level in the sump is less than 2.4 gallons based on a leak of 0.1 gallons per hour within 24 hours as provided in permit condition III.10.E.9.e.iii. Once the alarm is received, the sump liquids are transferred from the sump to the appropriate downstream vessel. The liquids may be recirculated to the vessel in the affected cell if it has been documented that the source of the sump liquid is the flushing of the vessel cell. The sumps and transfer lines are flushed with demineralized water (DIW) after any detected sump liquids are transferred.

Due to the design of the transfer pumps and suction lines, some residual flush liquids will remain in the vessel cell sumps after the sump has been pumped out and flushed. The second alarm point is a calculated leak detection rate that is used after the sump has been flushed, and some volume of flush liquids remain in the sump. The second alarm point, or LKY level rate of change function, will calculate any change in fluid level above the first alarm set point until the residual flush liquids evaporate. The LKY instrument function shown on Figure 2 detects a change in sump liquid levels when residual liquids remain in the sump and provides a means for detection of new liquids flushed, leaked, or spilled into the sump. A third alarm will alert the operator that the sump has reached its maximum volume.

3.3.2 Pump and Piping Pit Sumps

The sumps in the pump and piping pits are equipped with removable weir that after accumulating enough fluid to activate the leak detection alarm drains back to their respective vessel. Upon detection of a high liquid level in a pit sump, the control system alarms at which point the operator can remove the weir from the sump, flush the sump, and diagnose the source of the leak. Figure 3 shows the alarms for the level instrument associated with one of the C5 pump pit sumps (RLD-SUMP-00043A), which serves as a typical method of operation for all pit sumps in the LAB.

3.4 Leak Detection Boxes

The LAB has leak detection boxes on the headers **of the coaxial piping or double-walled piping** draining into the hotcell drain collection vessel (RLD-VSL-00165) and the lab area sink drain collection vessel (RLD-VSL-00164). The leak detection boxes **(LDBs)** are designed to detect a leak in the annular space of the coaxial. **The LDB is separated into two parts by a weir equipped with** a drain plug in the closed position to create a detectable **liquid** level. **A thermal level switch is used to** detect **liquid in the LDB, and activate** the control system alarms. **In the event of a level detection alarm, the source of the spill will be identified and isolated, and notifications, spill response and waste removal will be completed in accordance with WTP Operating and Spill Response procedures.** An overflow plug **is provided on the opposite side of the weir** in **an** open position **that** prevents **overfilling** of the leak detection box until it can be drained.

The leak detection boxes for the C3 drain collection headers drain to the C3 vessel cell sump (RLD-SUMP-**100041**). Similarly, the leak detection boxes for the C5 drain collection headers and the C3 transfer line for the lab area sink drain collection vessel (RLD-VSL-**00164**) drain to the C5 vessel cell sump (RLD-SUMP-**200042**). Figure 4 shows the alarm **function** for the **thermal** level **switch** instrument associated with one of the C3 transfer leak detection box (RLD-LDB-00004), which serves as a typical method of operation for all leak detection boxes in the LAB.

Table 1 Associated Instruments for LAB Radioactive Liquid Waste Disposal System

P&ID	Monitoring/control parameter	Type of instrument/control device	Instrument/control device tag number
24590-LAB-M6-RLD-00001001	Level Measurement for RLD-VSL-00165	Level Element	LE-6104
		Level Transmitter	LT-6104
		Level Indicator	LI-6104
24590-LAB-M6-RLD-00001001	Level Measurement for RLD-SUMP-00042	Level Transmitter	LT-6115
		Level Indicator	LI-6115
		Leak Rate	**LKY-6115**
24590-LAB-M6-RLD-00001002	Level Measurement for RLD-SUMP-00043A	Level Transmitter	LT-6116
		Level Indicator	LI-6116
24590-LAB-M6-RLD-00001003	Level Measurement for RLD-SUMP-00043B	Level Transmitter	LT-6124
		Level Indicator	LI-6124
24590-LAB-M6-RLD-00001004	Level Measurement for RLD-SUMP-00044	Level Transmitter	LT-6123
		Level Indicator	LI-6123
24590-LAB-M6-RLD-00002001	Level Measurement for RLD-VSL-00164	Level Element	LE-6202
		Level Transmitter	LT-6202
		Level Indicator	LI-6202
24590-LAB-M6-RLD-00002001	Level Measurement for RLD-SUMP-00041	Level Transmitter	LT-6211
		Level Indicator	LI-6211
		Leak Rate	**LKY-6211**
24590-LAB-M6-RLD-00002003	Level Measurement for RLD-SUMP-00045	Level Transmitter	LT-6212
		Level Indicator	LI-6212
24590-LAB-M6-RLD-00007001	Level Measurement for RLD-LDB-00005	Level High Switch	LSH-6215
		Level High Alarm	LAH-6215
24590-LAB-M6-RLD-00007001	Level Measurement for RLD-LDB-00006	Level High Switch	LSH-6701
		Level High Alarm	LAH-6701

24590-LAB-M6-RLD-00007001	Level Measurement for RLD-LDB-00007	Level High Switch	LSH-6702
		Level High Alarm	LAH-6702
24590-LAB-M6-RLD-00007001	Level Measurement for RLD-LDB-00008	Level High Switch	LSH-6703
		Level High Alarm	LAH-6703
24590-LAB-M6-RLD-00007001	Level Measurement for RLD-LDB-00011	Level High Switch	LSH-6704
		Level High Alarm	LAH-6704
24590-LAB-M6-RLD-00008001	Level Measurement for RLD-LDB-00002	Level High Switch	LSH-6120
		Level High Alarm	LAH-6120
24590-LAB-M6-RLD-00008001	Level Measurement for RLD-LDB-00004	Level High Switch	LSH-6118
		Level High Alarm	LAH-6118
24590-LAB-M6-RLD-00008001	Level Measurement for RLD-LDB-00009	Level High Switch	LSH-6801
		Level High Alarm	LAH-6801

Figure 1 Typical Drain Collection Vessel Level Detection

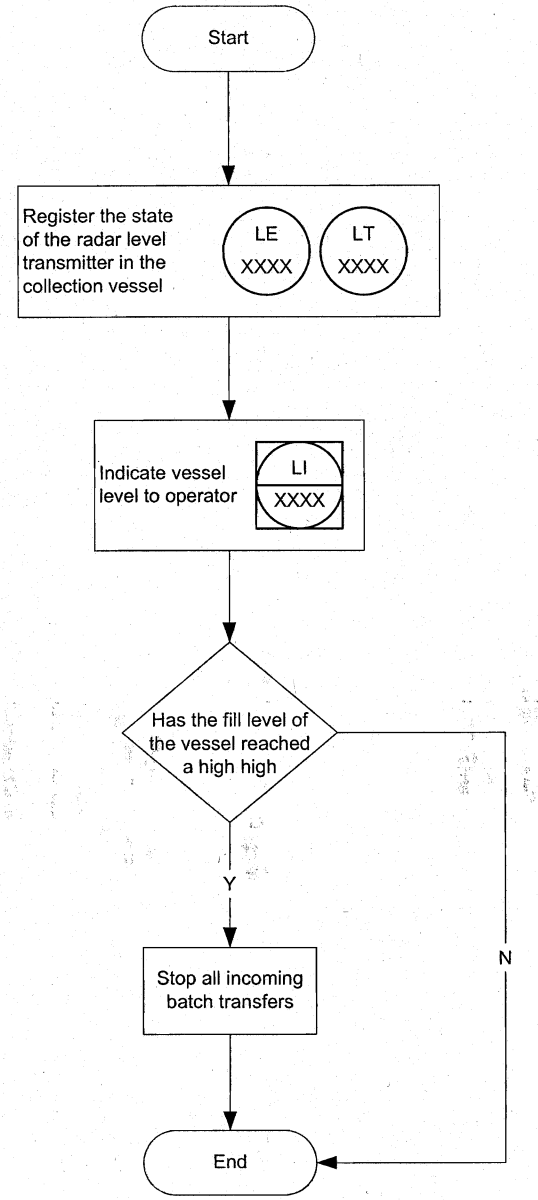

Figure 2 Typical Vessel Cell Sump Level Detection

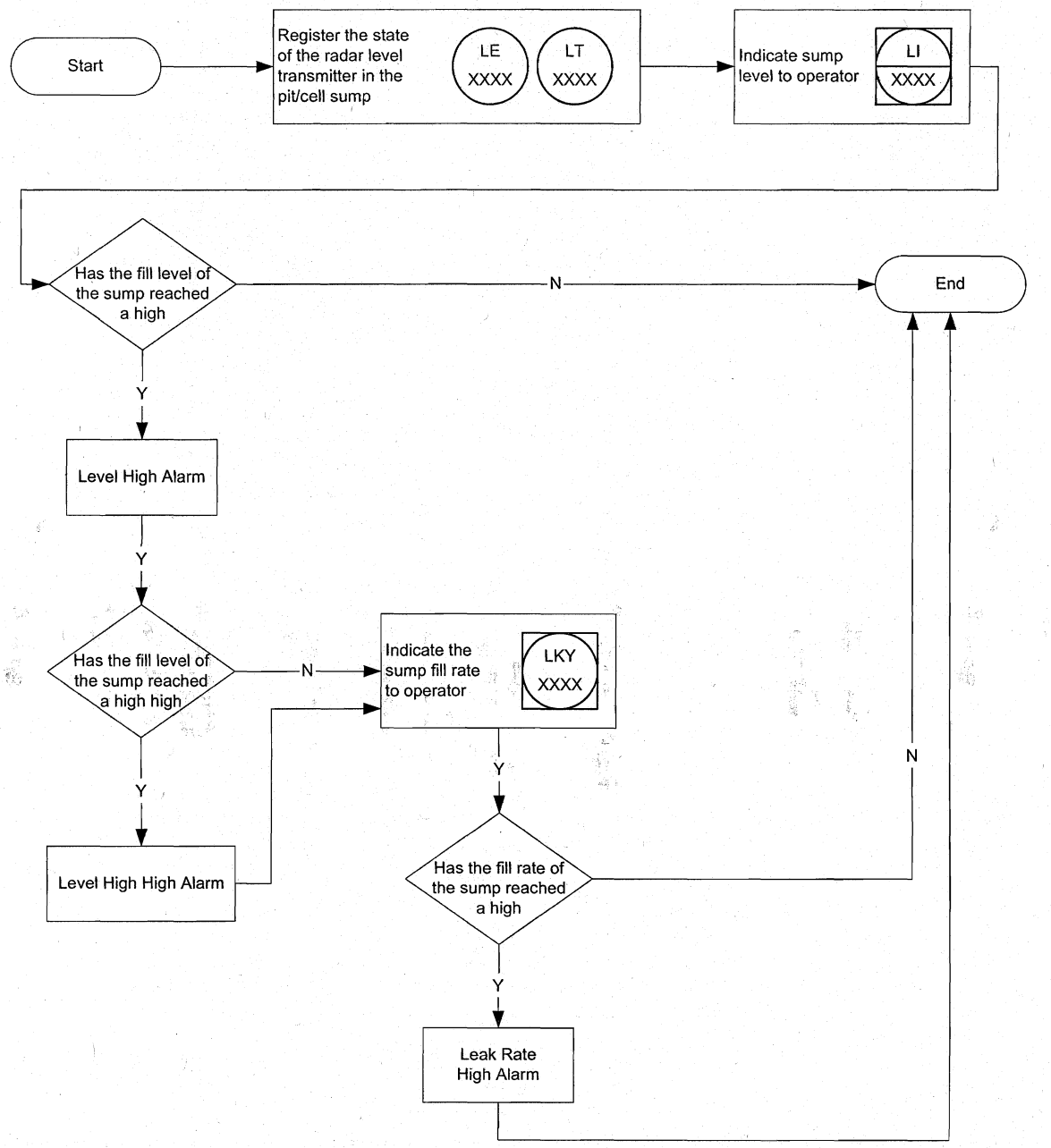

Figure 3 Typical Pump or Piping Pit (Equipment) Sump Level Detection

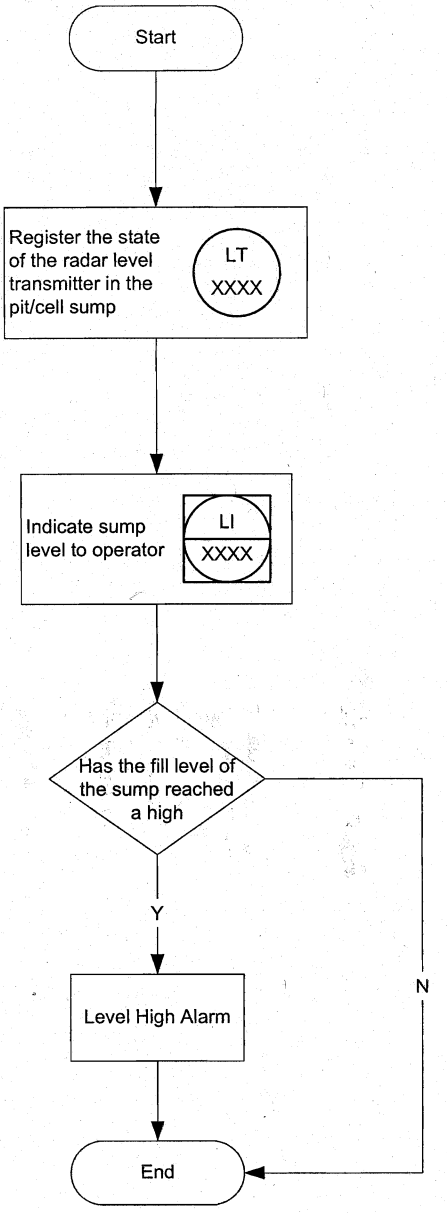

Figure 4 Typical Leak Detection Box Level Detection