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# LAB Waste Removal Capability for the Effluent Vessel Cells

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## Notice

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## History Sheet

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## Acronyms

AEA	Atomic Energy Act of 1954
C3	Originally an identification of radiological contamination level potential (in the context of this report it identifies or describes subsystems or components associated with the RLD-VSL-00164 tank system)
C5	Originally an identification of radiological contamination level potential (in the context of this report it identifies or describes subsystems or components associated with the RLD-VSL-00165 tank system)
DOE	US Department of Energy
LAB	Analytical Laboratory Facility
LDB	Leak Detection Box
NPS	Nominal Pipe Size
PIN	Plant Item Number
TDH	Total Dynamic Head
WAC	Washington Administrative Code

## 1 Summary

The Analytical Laboratory (LAB) effluent vessel cells (cells) must satisfy the waste removal criteria of Dangerous Waste Permit Number WA7890008967, Permit Condition III.10.E.9.e.iii for secondary containment systems. This report evaluates the capability for removing, within 24 hours, spills, leaked waste, and other liquids that may accumulate in the effluent vessel cells.

The effluent vessel cells are stainless steel lined. The liners are contoured to direct liquids to dry sumps in the cells. The cells and cell sumps are emptied by self-priming, centrifugal mechanical pumps that can transfer accumulated liquids to dangerous waste process vessels for storage and subsequent processing.

Calculations of waste removal capability verified that the containment area waste removal capacity for the C3 Effluent Vessel Cell (Room A-B003) is 2.4 hours. Similarly, the waste removal capacity for the C5 Effluent Vessel Cell (Room A-B004) is 3.1 hours. These values are well within the 24-hour period required by the regulations and stipulated by Permit Condition III.10.E.9.e.iii. The calculated values are based on consideration of the maximum operating volume of a single vessel in its respective cell, plus the maximum anticipated volume of firewater that is postulated to accumulate in these cells.

## 2 Objective

There are two dangerous waste vessels in the Analytical Laboratory (LAB). The first vessel, RLD-VSL-00164, the Laboratory Area Sink Drain Collection Vessel, will hereafter be referred to as the C3 Vessel. The second vessel, RLD-VSL-00165, the Hotcell Drain Collection Vessel, will hereafter be referred to as the C5 Vessel. The purpose of this report is to confirm the waste removal capabilities for the effluent vessel cell sumps associated with these two tank systems.

The C3 Effluent Vessel Cell (Room A-B003) and the C5 Effluent Vessel Cell (Room A-B004) must satisfy Dangerous Waste Permit Number WA7890008967, Permit Condition III.10.E.9.e.iii criteria for waste removal from secondary containment systems (Ref. 1 & 2). This report evaluates the capability for removing, within 24 hours, spills, leaked waste, and other liquids that may accumulate in the effluent vessel cells. The report examines sources and volumes of liquids that may accumulate in the cells, discusses provisions for the removal of accumulated liquids, and confirms the capability to remove accumulated liquids from the cells within 24 hours.

Excluded from the scope of this report are the dangerous waste lines that are embedded in the building foundation slab and the associated leak detection boxes (LDBs), and the pump and piping pit sumps. The LDBs are designed to direct excess leakage from the dangerous waste lines to their corresponding effluent vessel cell. Similarly, the pump and piping pit sumps are designed to direct excess leakage from the associated pit area to the corresponding effluent vessel.

### 3 Description

The Waste Treatment Plant Dangerous Waste Permit (Ref. 2), Permit Condition III.10.E.9.e.iii requires submittal of:

“Detailed operational plans and descriptions, demonstrating that spilled or leaked waste and accumulated liquids can be removed from the secondary containment system within twenty-four (24) hours [WAC 173-303-806(4)(c)(vii)].

This report confirms that the LAB waste removal capabilities satisfy these requirements.

### 4 Assumptions

Assumptions used in this evaluation of the Analytical Laboratory (LAB) effluent vessel cell waste removal capabilities are enumerated in the succeeding subsections.

- 4.1 Fire water discharges are based on a spray density of 0.17 gal/min·ft<sup>2</sup> over a “minimum design area” of 3000 ft<sup>2</sup> for a discharge duration of 20 minutes (Ref. 3)
- 4.2 The total dynamic head (TDH) requirements for the transfer of liquids from the C3 vessel cell sump to the C5 vessel are provided by current project design calculations.
- 4.3 The pump performance characteristics (i.e., pump curve data) for Pump RLD-PMP-00182A and B are given by the proposal documents of the selected pump vendor.
- 4.4 The TDH requirements for the transfer of liquids from the C5 vessel cell sump to PWD-VSL-00044 in the Pretreatment Facility (PTF) can be estimated from existing project design calculations. Minor elevation differences between the bottom of the C5 Vessel considered in the existing calculations and the bottom of the C5 effluent vessel sump are addressed herein.
- 4.5 The pump performance characteristics (i.e., pump curve data) for Pump RLD-PMP-00183A are given by the proposal documents of the selected pump vendor.
- 4.6 LAB dangerous waste inventories are sufficiently small compared to the liquid volumes that are routinely handled by the PTF Facility that there are no practical limits on when or how much waste can be transferred. Moreover, delays due to intermediate transfers between the C3 and C5 Vessels can be ignored for purposes of this evaluation. The C3 and C5 Vessel transfer capacities are comparable.
- 4.7 Operator response times needed for the manual alignment of valves and pump priming are ignored for the purposes of this evaluation. The cell liners are sized to accommodate 100% of the vessel volume or 20 minutes of firewater flow. In any event, prior to drawing suction from the effluent vessel cell sumps (cell sumps), the pump suction valves need to be re-aligned in order to draw suction from the cell sumps and the pumps may need to prime themselves prior to achieving rated flow capacities.

## 5 Analysis

### 5.1 C3 Effluent Vessel Cell (Room A-B003)

The C3 Effluent Vessel Cell houses the C3 Vessel. There are no other dangerous waste vessels in the cell. The cell is lined with stainless steel for secondary containment. The slope of the cell liner diverts effluents or other liquids towards the C3 Cell Sump (RLD-SUMP-00041). The sump is 30 inches nominal diameter and approximately 13 inches deep. The sump is made from a piece of nominal pipe size (NPS 30) standard-wall pipe (or an equivalent rolled plate) and a 30-in diameter, standard-wall, pipe cap (or equivalent ellipsoidal-head section) and has a nominal volume of 30 gallons. The sump is emptied by pump RLD-PMP-00182A or 00182B into the C5 Vessel, located in Room A-B004, or emptied into the C3 vessel, located in Room A-B003. For major breaches of the primary containment or major firewater discharges to the cell, accumulated liquids are contained by the combined volumes of the sump and the lined portions of the cell. Under these circumstances, the accumulated liquids will be removed from the cell and be transferred to the C5 Vessel for subsequent storage, transfer, and processing. The bounding calculations consider three potential scenarios: (1) removal of the breached-vessel contents from the cell, (2) removal of firewater overflow discharges from the cell, and (3) removal of all accumulated liquids from the vessel and the associated cell.

### 5.2 C5 Effluent Vessel Cell (Room A-B004)

The C5 Effluent Vessel Cell is similar to the one described in section 5.1 above. The associated sump, C5 Cell Sump (RLD-SUMP-00042), is emptied via pump RLD-PMP-00183A into the Plant Wash Vessel, PWD-VSL-00044, in the PTF Facility, through a buried, double-walled (duplex) transfer line or emptied into the C5 vessel in Room A-B004. For major breaches of the primary containment or major firewater discharges to the cell, the accumulated liquids will be removed from the cell and transferred to PWD-VSL-00044 (the PT Plant Wash Vessel) for subsequent storage and processing. The bounding calculations consider the same three waste removal scenarios described previously.

## 6 Sump Removal Rates

The results of this evaluation are compiled in the table below based on the two cases that are evaluated in Section 7, Bounding Calculations. The table demonstrates that the C3 Effluent Vessel Cell [and the associated C3 Cell Sump (RLD-SUMP-00041)] and the C5 Effluent Vessel Cell [and the associated C5 Cell Sump (RLD-SUMP-00042)] have sufficient emptying capacity to remove spills, leaks, or other accumulated liquids from their respective effluent vessel cells within 24 hours. The 24-hour criterion corresponds to the requirement in Permit Condition III.10.E.9.e.iii.



The “largest vessel waste removal capacity”, the “fire water volume”, and the “total containment area waste removal capacity” are thus the following, respectively:

- Maximum Operating Volume: 2740 gal \* (min/90 gal) \* (h/60 min) = 0.5 h
- Maximum Firewater Volume: 10,200 gal \* (min/90 gal) \* (h/60 min) = 1.9 h
- Total Containment Area Volume: 12,940 gal \* (min/90 gal) \* (h/60 min) = 2.4 h.

## 7.2 C5 Effluent Vessel Cell, Room A-B004

The C5 Effluent Vessel Cell contains the C5 Vessel. Leak collection and detection for the C5 Effluent Vessel Cell is provided by RLD-SUMP-00042 and the associated level instrumentation. The sump is emptied by pump RLD-PMP-00183A.

There are no fire suppression sprinklers in the C5 Effluent Vessel Cell. All firewater postulated to accumulate in the cell originates from other areas of the facility.

The liquid volumes of interest that must be removed from the area are the following (Ref. 3):

- Maximum Operating Volume of the C5 Vessel: 6615 gal
- Maximum Firewater Volume: 20 min \* (0.17 gal/min·ft<sup>2</sup>) \* (3000 ft<sup>2</sup>) = 10,200 gal (Assumption 4.1)
- Total Containment Area Volume: 6615 gal + 10,200 gal = 16,815 gal (round to 16,820 gal)

Based on inspection of system design calculations, the TDH @ 60 gal/min needed to pump the C5 Vessel to the PTF Plant Wash Vessel (PWD-VSL-00044) is approximately 78.3 ft-H<sub>2</sub>O (Assumption 4.4). The TDH requirement for transfers from the C5 effluent vessel sump to PTF Vessel PWD-VSL-00044 is 2 to 3 ft-H<sub>2</sub>O more.

Per system design calculations, the system curve for this mode of operation is estimated using the following equation:

$$H = \left( \frac{15.5 \text{ ft} \cdot H_2O}{(60 \text{ gpm})^2} \right) Q^2 + 62.79 \text{ ft} \cdot H_2O$$

<u>Q, gpm</u>	<u>H, ft-H<sub>2</sub>O</u>
40	70
60	78
80	90
85	94
90	98
95	102
100	<b>106 ~ Pump Intersection</b>
105	110
110	115
120	125

Superimposing these points onto the pump performance curve, the operating point (i.e., the intersection of the pump curve and the system curve) is approximately 100 gal/min and 106 ft-H<sub>2</sub>O. These values define the expected output of the pump. The actual flow is anticipated to be modestly less because the system curve is based on discharge from the C5 Vessel, rather than the C5 effluent vessel sump. Again, per Ref. 4, pg. B-14, the corresponding fluid velocity through a NPS 3, Sch. 40 pipe is only about 4 ft/s. This value is well within the pipe-sizing limits and a flow of 100 gal/min would be reasonable. However, for conservatism, use a value of 90 gal/min or 5400 gal/h.

The “largest vessel waste removal capacity”, the “fire water volume”, and the “total containment area waste removal capacity” are thus the following, respectively:

- Maximum Operating Volume:  $6615 \text{ gal} * (\text{min}/90 \text{ gal}) * (\text{h}/60 \text{ min}) = 1.2 \text{ h}$
- Maximum Firewater Volume:  $10,200 \text{ gal} * (\text{min}/90 \text{ gal}) * (\text{h}/60 \text{ min}) = 1.9 \text{ h}$
- Total Containment Area Volume:  $16,820 \text{ gal} * (\text{min}/90 \text{ gal}) * (\text{h}/60 \text{ min}) = 3.1 \text{ h}$

## **8 References**

1. WAC 173-303, *Dangerous Waste Regulations*, Washington Administrative Code.
2. Permit Number WA7890008967, *Dangerous Waste Portion of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous, Waste*, Chapter 10 and Attachment 51, “Waste Treatment and Immobilization Plant”.
3. 24590-LAB-PER-M-02-001, *Flooding Volumes for LAB Facility*, Rev. 0.
4. Crane, *Flow of Fluid Through Valves, Fittings, and Pipe*, Crane Co., 300 Park Ave., New York, NY 10022, 21st Printing (1982).