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Notice

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Contents

Appendices

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)
CCN	Correspondence Control Number
DOE	US Department of Energy
DWP	Dangerous Waste Permit
LAB	Analytical Laboratory Facility
LDB	Leak Detection Box
NPS	Nominal Pipe Size
PDC	WTP Project Archives & Document Control
PIN	Plant Item Number
UBC	Uniform Building Code
WAC	Washington Administrative Code
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1 Introduction

The Washington Administrative Code, WAC 173-303, requires that secondary containment be designed and operated to contain 100% of the capacity of the largest tank within its boundary for tank systems that contain dangerous waste. This report discusses the assessment of the liner heights and the flooding volumes that are required to be contained for the River Protection Project - Waste Treatment Plant (WTP) analytical laboratory (LAB). The LAB has two dangerous waste vessels: the laboratory area sink drain collection vessel (RLD-VSL-00164) and the hotcell drain collection vessel (RLD-VSL-00165). 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.

2 Applicable Documents

WAC 173-303. *Dangerous Waste Regulations.* Washington Administrative Code.

Publication #95-420, Guidance for Assessing Dangerous Waste Secondary Containment Systems, Washington Department of Ecology, September 1995.

UBC, 1997, Uniform Building Code™

3 Description

There are two dangerous waste vessels in the LAB. The first vessel, RLD-VSL-00164, laboratory area sink drain collection vessel, will hereafter be referred to as the C3 vessel (RLD-VSL-00164). The second vessel, RLD-VSL-00165, hotcell drain collection vessel, will hereafter be referred to as the C5 vessel (RLD-VSL-00165).

The C3 vessel (RLD-VSL-00164) collects, by gravity flow, effluents and other inflows from the radiological laboratory fumehood sinks, radiological laboratory sinks, maintenance area floor drains, pump maintenance room drains, hotcell maintenance access area floor drains, personnel decontamination showers and sinks, process vacuum system equipment drains, and a maintenance area sink. These sources of influent are all located at grade level. In addition, the C3 vessel (RLD-VSL-00164) receives liquid transfers from RLD-VSL-00163, floor drain collection vessel (C2 vessel), and sump drain flows from the C3 pump pit (A-B002). RLD-VSL-00164 is located at elevation (-)18'-7". The vessel is located in a stainless steel lined, rectangular cell and is the only vessel in that cell. The cell is designated room A-B003, C3 effluent vessel cell.

The C5 vessel (RLD-VSL-00165) collects, by gravity flow, effluents and other inflows from laboratory hotcell floor drains, hotcell cupsinks, hotcell transfer drawer drains, hotcell transfer glovebox drains, autosampling system drains, and a maintenance decontamination glovebox drain. In addition, the vessel receives effluent transfers from the previously described C3 vessel (RLD-VSL-00164), liquid transfers from RLD-VSL-00163, floor drain collection vessel (C2 vessel), and sump drain flows from the C5 pump pits (A-B005 and A-B007) and C5 piping pit (A-B006). RLD-VSL-00165 is located at elevation (-)19'-

2". It is housed in a stainless steel lined, rectangular cell and is the only vessel in that cell. The cell is designated room A-B004, C5 effluent vessel cell.

3.1 C3 vessel Secondary Containment for LAB Facility

Flooding could occur in the cell if there is a failure of the vessel or a release of fire water that causes the vessel to overflow via its overflow nozzle. The greater flooding volume of the two scenarios determines the required height of the stainless steel liner for the C3 effluent vessel cell.

The WTP design criteria for flooding due to a vessel failure is defined as either 110% of the maximum operating volume of the largest vessel in the cell or the total volume of the largest vessel, whichever is greater. The total volume is defined as the internal volume of the vessel, including the shell and both heads. In this case, there is only one vessel in the cell and its total volume of 3200 gal (427.8 ft^3) is the greater volume. This is the volume that is used for calculating the cell stainless steel liner height.

Two cases are evaluated based on the different code requirements. Both cases are evaluated and the greater liner height is used.
Scenario A: "Tank" or vessel is ruptured (WAC) plus In-Cell Fire Water Volume (If equipped)
Scenario B: "Tank" or vessel full plus remote Fire Water Volume (UBC)(fire water input from higher elevation floor drains to a filled vessel).

For Scenario A, the flooding height is calculated by the summation of the total volume of the C3 vessel plus 20 minutes of fire water flow into the vessel cell minus the volume of the sloped floor divided by the net cell floor area. The C3 vessel cell has a floor area of ≈354 ft^2. The fire water flow into the C3 vessel cell was estimated based on a sprinkler spray density of 0.17 gal/min-ft^2 (gallons per minute per square foot), a minimum design area for a period of 20 minutes, plus a 1.1 margin. Therefore, the total amount of fire water from sprinklers inside the cell is 1325 gal (177 ft^3). In addition, an allotment was made for displacement due to piping, vessel supports, and other commodities that may be found in the cell. The top of the stainless steel liner above the poured concrete floor required for a postulated vessel failure is 1.70 ft.

Scenario B examines the collection of fire water discharges when the vessel is full and intact and firewater from floor drains in the largest upper elevation area overflow the vessel resulting in the flooding of the C3 effluent vessel cell. The largest firewater volume that can drain into RLD-VSL-00164 comes from the C3 Maintenance Shop that has a floor area of ≈2300 ft^2. Scenario B also uses a sprinkler spray density of 0.17 gal/min-ft^2 (gallons per minute per square foot), into the C3 Maintenance shop for a period of 20 minutes, plus a 1.1 margin. Therefore, the total amount of fire water that is collected in the vessel and presumed to overflow into the cell is 8602 gal (1150 ft^3).

The required height for Scenario B is equal to the fire water flooding volume minus the volume of the sloped floor area divided by the cross-sectional area of the cell compartment minus the vessel area. The top of the stainless steel liner above the poured concrete floor required for flooding due to a postulated fire water discharge is 3.8 ft.

The installed liner height is 4.96 ft, therefore the liner is sufficient for both scenarios. A derivation of the liner height calculation is provided in Appendix A.

3.2 C5 Vessel Secondary Containment for LAB Facility

The C5 vessel (RLD-VSL-00165) is the only vessel in the respective cell. Flooding could occur in the cell if there is a failure of the vessel or a release of fire water that causes the vessel to overflow via its overflow nozzle. The worst of the two scenarios determines the required height of the stainless steel liner for the C5 effluent vessel cell.

The WTP design criteria for flooding due to a vessel failure is defined as either 110% of the maximum operating volume of the largest vessel in the cell or the total volume of the largest vessel, whichever is greater. The total volume is defined as the internal volume of the vessel, including the shell and both heads. In this case, there is only one vessel in the cell and its total volume of 9100 gal (1216.5 ft^3) is the greater volume. This is the volume that is used for calculating the cell stainless steel liner height.

Two cases are evaluated based on the different code requirements. Both cases are evaluated and the greater liner height is used.

Scenario A: "Tank" or vessel is ruptured (WAC) plus In-Cell Fire Water Volume (If equipped)
Scenario B: "Tank" or vessel full plus remote Fire Water Volume (UBC)(fire water input from higher elevation floor drains to a filled vessel).

For Scenario A, the flood height is calculated by the summation of the total volume of the C5 vessel minus the volume of the sloped floor divided by the net cell floor area. There are no in-cell fire sprinklers in the C5 vessel cell, so sprinkler flow was not considered in Scenario A. In addition, an allotment was made for displacement due to piping, vessel supports, and other commodities that may be found in the cell. The top of the stainless steel liner above the poured concrete floor required for a postulated vessel failure is 1.90 ft.

For Scenario B the required liner height is equal to the hot cell fire water flooding volume minus the volume of the sloped floor area divided by the cross-sectional area of the cell compartment minus the vessel area. In addition, an allotment was made for displacement due to piping, vessel supports, and other commodities that may be found in the cell. The largest firewater volume that can drain into RLD-VSL-00165 is from the Hotcells that has a floor area of $\approx$2300 ft^2. The flooding due to fire water entering the drain collection system through floor drains and overflowing the C5 vessel (RLD-VSL-00165) was estimated based on a sprinkler spray density of 0.17 gal/min-ft^2 (gallons per minute per square foot), a minimum design area for a period of 20 minutes, plus a 1.1 margin. Therefore, the total amount of fire water that is collected in the vessel and presumed to overflow into the cell is 8602 gal (1150 ft^3). The top of the stainless steel liner above the poured concrete floor required for flooding due to a postulated fire water discharge is 2.7 ft.

The installed liner height is 4.0 ft, therefore the liner is sufficient for both scenarios. A derivation of the liner height calculation is provided in Appendix B.

Appendix A

Calculation of Liner Height for RLD-VSL-00164 Cell

Calculation of Liner Height for RLD-VSL-00164 Cell

A.1 Objective

The purpose of this calculation is to size the height of the liner in the C3 effluent vessel cell (A-B003) at the (-)18'-7" elevation of the WTP analytical laboratory (for the C3 vessel, RLD-VSL-00164). The general arrangement of the cell is illustrated in drawing 24590-LAB-P1-60-00007.

A.2 Inputs

The following input parameters and physical characteristics are used as input to this calculation.

- Vessel characteristics: 8'-6" (102.0 in.) diameter x 8'-79/16" (103.6 in.) height (flanged and dished heads, top and bottom)
- Vessel volume: total volume = 3200 gal (427.8 ft^3), maximum operating volume = 2740 gal (366.3 ft^3)
- Cell dimensions: 27'-3" (long, north/south) x 13'-0" (wide, east/west) x 10'-0" (high)
- duration of a fire water discharge is 20 minutes
- Fire sprinkler design criteria: The minimum spray density for laboratory process areasand mechanical rooms is 0.17 gal/min-ft^2 times 1.1 over the minimum design area of 3000 ft^2 (See Design Guide WTP-GPG-M-033, Sect. 3, page 10 of 15)
- Fire protection water: Per Uniform Building Code (UBC), Sec. 307.2.3.3, "Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel, plus the design flow volume of fire-protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes. Based on these UBC criteria the C3 Maintenance Shop (≈2300 ft^2) was selected to evaluate fire protection water drain flow into RLD-VSL-00164 (Scenario B).
- Liner sizing criterion: The liner must be designed to contain either 110% of the maximum operating volume of the largest vessel in the cell or the total volume of the largest vessel, whichever is greater; and handle the volume of fire water from the fire protection system over the minimum design area for a period of 20 minutes (with the vessel full)

The characterization of the fire and fire sprinkler system is based on the design guide 24590-WTP-GPG-M-019. The design criterion for the liner is based on a review of Washington Administrative Code requirements and referenced standards. The vessel volumes are conservative values.

A.3 Background

This calculation is being performed to support dangerous waste permit modifications for the analytical laboratory (LAB) facility.

A.4 Applicable Codes and Standards

WAC 173-303. *Dangerous Waste Regulations.* Washington Administrative Code.

Publication #95-420, Guidance for Assessing Dangerous Waste Secondary Containment Systems, Washington Department of Ecology, September 1995.
United Building Code, 1997

A.5 Methodology

This is a manual calculation that uses well-known and recognized handbook formulas. The general approach is to calculate the total volume of liquid that potentially enters the cell and divide that value by the net available floor area to obtain the flooding height in the cell.

Liquid can enter the cell if there is a failure of the vessel in the corresponding cell or a release of fire water that causes the vessel to overflow. For the vessel rupture cases, the total volume of the vessel in the corresponding cell is discharged to the cell. In contrast, for the fire water cases, liquid enters the drain collection system through floor drains located at various grade-level rooms throughout the analytical laboratory building and the collected liquid causes the vessel to overflow into the corresponding cell. The intact vessel is taken to be full at the start of the fire water discharge.

A.6 Assumptions

The following assumptions are used in the calculation.

A.6.1 For the scenario of a vessel spill, credit is taken for any fluid volume that remains in the vessel as the fluid level will equalize between vessel and cell. This assumption does not require verification.

A.6.2 The volume displaced by the piping, vessel supports, and other obstructions in the cell is assumed to equal 5% of the volume displaced by the vessel. By inspection, the few pipes or other commodities located in the vessel cells are open and do not significantly contribute to volume reduction. This assumption is deemed to be conservative and does not require verification.

A.6.3 For the scenario of a full vessel, the area of the vessel is subtracted from the gross area of the cell floor. This assumption is conservative and does not require verification.

A.7 Calculations

A.7.1 C3 Vessel (RLD-VSL-00164) Rupture Plus In-Cell Firewater Release (Scenario A)

A.7.1.1 Vessel Characteristics

Vessel dimensions: 8'-6" (8.50 ft) diameter x 8'-7 9/16" (8.63 ft) height (flanged-and-dished heads, top and bottom).

Total Volume = 3,200 gal (427.8 ft^3) 110% MOV = 1.1 * 2,740 gal = 3,014 gal

Therefore, the vessel capacity used in liner height calculation is 3,200 gal (427.8 ft^3).

A.7.1.2 Cell Characteristics

Cell Dimensions: [27'-3" (long)] x [13'-0" (wide)]

Based on Assumption A.6.2, the net cell floor area is given by the following:

Net Cell Floor Area (A_f) = Gross Area – 5% of Vessel Area for unknowns (e.g., piping, vessel supports, etc.)

Vessel outside diameter: 8.50 ft (internal diameter) + 2*(0.375"/12 in/ft) (shell thickness) = 8.5625 ft.

A_f= [27.25 ft*13.00 ft] – [0.05 *(1/4)* π*(8.5625 ft)^2]

A_f= 354.25 ft^2 – 2.88 ft^2 = 351.4 ft^2

A.7.1.3 Fire Water Flood Characteristics:

$$V_{ol} = (T)(0.17)(A_{fw})(1.1)$$

Where:
T = 20 minutes
A_{fw} = 354.25 ft^2
Therefore, fire water flooding volume is equal to: V_{ol} = 20 min * (0.17 gal/min-ft^2) * (354.25 ft^2)*(1.1) = 1324.9 gal (177.1 ft^3)

A.7.1.4 Sloped Floor Volume

The cell floor is sloped 2 inches (0.17 ft) to direct potential leaks to the secondary containment sump. Credit is taken for the volume of the sloped floor from the base of the liners to the top of the sump by subtracting the calculated volume from the vessel and fire water flood volumes.
The volume of the sloped floor section is calculated using:

$$V_s = (h_s/3)(A_f + \sqrt{A_f A_1} + A_1) = (0.17/3)(354.25 + \sqrt{(354.24)(10.03)} + 10.03) = 24.02 ft^3$$

Where A_1 = 3.167' x 3.167' = 10.03 ft^2 (area of floor at top of sump)

A.7.1.5 Required Liner Height (H)

Flood Height = (Vessel Volume + Fire Water Flood Volume - Sloped Floor Volume) / Net Cell Floor Area =

(427.8 + 177.1 - 24.02) ft^3 / 351.4 ft^2 =

(580.88) ft^3 / 351.4 ft^2 = 1.653 ft $\cong 1.70 ft$

The required liner height, H = 1.70 ft (Scenario A)

A.7.2 C3 Vessel (RLD-VSL-00164) Full Plus Remote Firewater Release volume (Scenario B)

A.7.2.1 Flood Height

Flood Height = Remote Floodwater Volume / (Cell Floor Area -Vessel Area)

A.7.2.2 Cell Characteristics, A-B003

Cell Dimensions: [27'-3" (long)] x [13'-0" (wide)]

Based on Assumption A.6.3, the net cell floor area minus the vessel area is given by the following:

Net Cell Floor Area (A_f) = Gross Area – Vessel Area

Vessel outside diameter: 8.50 ft (internal diameter) + 2*(0.375"/12 in/ft) (shell thickness) = 8.5625 ft.

A_f = [27.25 ft*13.00 ft] – [(1/4)* π*(8.5625 ft)^2]

A_f = 354.25 ft^2 – 57.58 ft^2 = 296.67 ft^2

A.7.2.3 Fire Water Flood Characteristics

The largest firewater volume that can drain into RLD-VSL-00164 is from the C3 Maintenance Shop

The floor area of the C3 Maintenance Shop is calculated below:

A_{ms} = 58.6875' x 39' = 2289 ft^2 ≈ 2300 ft^2

Remote Floodwater Volume from the largest area with fire sprinkler service draining to vessel (C3 Maintenance Area) =

$$V_{ol} = (T)(0.17)(A_{fw})(1.1)$$

Where:
T = 20 minutes
A_{fw} = A_{ms} = 2300 ft^2
Therefore, fire water flooding volume is equal to: V_{ol} = 20 min * (0.17 gal/min-ft^2) * (2300 ft^2)*(1.1) = 8602 gal (1150 ft^3)

A.7.2.4 Sloped Floor Volume

The cell floor is sloped 2 inches (0.17 ft) to direct potential leaks to the secondary containment sump. Credit is taken for the volume of the sloped floor from the base of the liners to the top of the sump by subtracting the calculated volume from the vessel and fire water flood volumes.
The volume of the sloped floor section is calculated using:

$$V_s = (h_s/3)(A_f + \sqrt{A_f A_1} + A_1) = (0.17/3)(354.25 + \sqrt{(354.24)(10.03)} + 10.03) = 24.02\,ft^3$$

Where A_1 = 3.167' x 3.167' = 10.03 ft^2 (area of floor at top of sump)

A.7.2.5 Required Liner Height

Flood Height = (Fire Water Flood Volume - Sloped Floor Volume)/Net Cell Floor Area =
(1150 - 24.02) ft^3 / 296.67 ft^2 = 3.8 ft

The required liner height, H = 3.8 ft (Scenario B)

A.8 Results and conclusions

The required liner height is 1.70 ft. for Scenario A.
The required liner height is 3.80 ft. for Scenario B.
Installed liner height of 4.96 ft (4'-11.5") as measured from the highest point on the concrete floor exceeds the minimum liner height requirement and therefore it is adequate.

A.9 References

A.9.1 24590-LAB-P1-60-00007, Rev. 002, ANALYTICAL LABORATORY GENERAL ARRANGEMENT PLAN AT EL (-) 19 FT - 2IN SECTIONS E-E, F-F & G-G.

A.9.2 24590-WTP-GPG-M-033, Rev. 004, Fire Water Floor Drain System.

A.9.3 24590-QL-SRA-MTF5-00001-44-00007, Rev. 00B, Drawings - Analytical Laboratory C3 Cell Details - Dwg. No. 206.

A.10 Attachments

None

Appendix B

Calculation of Liner Height for RLD-VSL-00165 Cell

Appendix B
Calculation of Liner Height for RLD-VSL-00165 Cell

B.1 Objective

The purpose of this calculation is to size the height of the liner in the C5 effluent vessel cell (A-B004) at the (-)19'-2" elevation of the WTP analytical laboratory (for the C5 vessel, RLD-VSL-00165). The general arrangement of the cell is illustrated in drawing 24590-LAB-P1-60-00007.

B.2 Inputs

The following input parameters and physical characteristics are used as input to this calculation.

- Vessel characteristics: 16'-0" (192.0 in.) diameter x 8'-2" (98 in.) height (flanged and dished heads, top and bottom)
- Vessel volume: total volume = 9100 gal (1216.5 ft^3), maximum operating volume = 6615 gal (884.3 ft^3)
- Cell dimensions: 29'-0" (long, north/south) x 21'-0" (wide, east/west) x 11'-2" (high)
- Duration of a fire water discharge is 20 minutes
- Fire sprinkler design criteria: The minimum spray density for laboratory process area, including hotcell support rooms, laboratory suites and corridors, and mechanical rooms is 0.17 gal/min-ft^2 times 1.1 over the minimum design area of 3000 ft^2 (See Design Guide WTP-GPG-M-033, Sect. 3, page 10 of 15)Fire protection water: Per Uniform Building Code (UBC), Sec. 307.2.3.3, "Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel, plus the design flow volume of fire-protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller, for a period of 20 minutes. Based on these UBC criteria the Hotcell area (≈2300 ft^2) was selected to evaluate fire protection water drain flow into RLD-VSL-00165 (Scenario B).

- Liner sizing criterion: The liner must be designed to contain either 110% of the maximum operating volume of the largest vessel in the cell or the total volume of the largest vessel, whichever is greater; and handle the volume of fire water from the fire protection system over the minimum design area for a period of 20 minutes (with the vessel full)

The characterization of the fire and fire sprinkler system is based on the design guide 24590-WTP-GPG-M-019. The design criterion for the liner is based on a review of Washington Administrative Code requirements and referenced standards. The vessel volumes are conservative values.

B.3 Background

This calculation is being performed to support dangerous waste permit modifications for the analytical laboratory (LAB) facility.

B.4 Applicable Codes and Standards

WAC 173-303. *Dangerous Waste Regulations.* Washington Administrative Code.

Publication #95-420, Guidance for Assessing Dangerous Waste Secondary Containment Systems, Washington Department of Ecology, September 1995.
United Building Code, 1997

B.5 Methodology

This is a manual calculation that uses well-known and recognized handbook formulas. The general approach is to calculate the total volume of liquid that potentially enters the cell and divide that value by the net available floor area to obtain the flooding height in the cell.

Liquid can enter the cell if there is a failure of the vessel in the corresponding cell or a release of fire water that causes the vessel to overflow. For the vessel rupture cases, the total volume of the vessel in the corresponding cell is discharged to the cell. In contrast, for the fire water cases, liquid enters the drain collection system through floor drains located at various grade-level rooms throughout the analytical laboratory building and the collected liquid causes the vessel to overflow into the corresponding cell. The intact vessel is taken to be full at the start of the fire water discharge.

B.6 Assumptions

The following assumptions are used in the calculation.

B.6.1 For the scenario of a vessel spill, credit is taken for any fluid volume that remains in the vessel as the fluid level will equalize between vessel and cell. This assumption is conservative and does not require verification.

B.6.2 The volume displaced by the piping, vessel supports, and other obstructions in the cell is assumed to equal 5% of the volume displaced by the vessel. By inspection, the few pipes or other commodities located in the vessel cells are open and do not significantly contribute to volume reduction. This assumption is deemed to be conservative and does not require verification.

B.6.3 For the scenario of a full vessel, the area of the vessel is subtracted from the gross area of the cell floor. This assumption is conservative and does not require verification.

B.7 Calculations

B.7.1 C5 Vessel (RLD-VSL-00165) Rupture (Scenario A)

B.7.1.1 Vessel Characteristics

Vessel Dimensions: 16 ft Dia. x 8.17 ft H (Flanged-and-Dished-Heads Top and Bottom)

Total Volume = 9,100 gal (1,216.5 ft^3) 110% MOV = 1.1 * 6,615 gal = 7,277 gal

Therefore, the vessel capacity used to calculate the liner height is equal to 9,100 gal (1,216.5 ft^3).

B.7.1.2 Cell characteristics

Cell Dimensions: [29'-0" (long)] x [21'-0" (wide)]

Based on Assumption B.6.2, the net cell floor area is given by the following:
Net Cell Floor Area (A_f) = Gross Area – 5% of Vessel Area for unknowns (e.g., piping, vessel supports, etc.)

Vessel outside diameter : 16.0 ft (internal diameter) + 2*(0.688"/12) (shell thickness) = 16.115 ft

A_f = [29.00 ft*21.00 ft] – [0.05 *(1/4)*π*(16.115 ft)^2]

A_f = 609.00 ft^2 – 10.2 ft^2 = 598.8 ft^2

B.7.1.3 Fire Water Flood Characteristics:

There are No Sprinklers in C5 Cell.

B.7.1.4 Sloped Floor Volume

The cell floor is sloped 4 inches (0.33 ft) to direct potential leaks to the secondary containment sump. Credit is taken for the volume of the sloped floor from the base of the liners to the top of the sump by subtracting the calculated volume from the vessel and fire water flood volumes.
The volume of the sloped floor section is calculated by:

$$V_s = (h_s/3)(A_f + \sqrt{A_f A_l} + A_l) = (0.33/3)(609 + \sqrt{(609)(11.11)} + 11.11) = 77.26 ft^3$$

Where A_l = (1'-8" + 1'-8") x (1'-8" + 1'-8") = 3.33' x 3.33' = 11.11 ft^2 (area of floor at top of sump)

B.7.1.5 Required Liner Height (H)

Flood Height = (Ruptured Vessel Volume - Sloped Floor Volume) / Net Cell Floor Area =

(1216.5 - 77.26) ft^3 / 598.8 ft^2 =

(1139.24)ft^3 / 598.8 ft^2 = 1.90 ft

The required liner height, H = 1.90 ft (Scenario A)

B.7.2 C5 Vessel (RLD-VSL-00165) Full Plus Remote Firewater Release Volume (Scenario B)

B.7.2.1 Flood Height

Flood Height = Remote Floodwater Volume / (Cell Floor Area -Vessel Area)

B.7.2.2 Cell Characteristics, A-B004

Cell Dimensions: [29'-0" (long)] x [21'-0" (wide)]

Based on Assumption B.6.3, the net cell floor area is given by the following:

Net Cell Floor Area (A_f) = Gross Area – Vessel Area

Vessel outside diameter : 16.0 ft (internal diameter) + 2*(0.688"/12) (shell thickness) = 16.115 ft

A_f = [29.00 ft*21.00 ft] – [1/4*π*(16.115 ft)^2]

A_f= 609.0 ft^2 – 203.96 ft^2 = 405.0 ft^2

B.7.2.3 Fire Water Flood Characteristics

The largest fire water volume that can drain into RLD-VSL-00165 is from the Hot Cell Area (HC-1 through HC-14) [A0141B].

The floor area of the Hot Cells is calculated below:

A_{HC} = 20' x 115' = 2300 ft^2

$$V_{ol} = (T)(0.17)(A_{fw})(1.1)$$

Where:
T = 20 minutes
A_{fw} = A_{HC} = 20' x 115' = 2300 ft^2

Therefore, fire water flooding volume is equal to: V_{ol} = 20 min * (0.17 gal/min-ft^2) * (2300 ft^2)*(1.1) = 8602 gal (1149.8 ft^3)

B.7.2.4 Sloped Floor Volume

The cell floor is sloped 4 inches (0.33 ft) to direct potential leaks to the secondary containment sump. Credit is taken for the volume of the sloped floor from the base of the liners to the top of the sump by subtracting the calculated volume from the vessel and fire water flood volumes.
The volume of the sloped floor section is calculated by:

$$V_s = (h_s/3)(A_f + \sqrt{A_f A_1} + A_1) = (0.33/3)(609 + \sqrt{(609)(11.11)} + 11.11) = 77.26 ft^3$$

Where A_1 = (1'-8" + 1'-8") x (1'-8" + 1'-8") = 3.33' x 3.33' = 11.11 ft^2 (area of floor at top of sump)

B.7.2.5 Required Liner Height

Flood Height = (Fire Water Flood Volume - Sloped Floor Volume)/Net Cell Floor Area =

(1149.8 - 77.26) ft^3 / 405.0 ft^2 =
(1072.54)ft^3 / 405.0 ft^2 = 2.65 ft $\cong 2.70 ft$

The required liner height, H = 2.70 ft (Scenario B)

B.8 Results and Conclusions

The required liner height is 1.90 ft. for Scenario A.
The required liner height is 2.70 ft. for Scenario B.
Installed liner height of 4.0 ft as measured from the highest point on the concrete floor exceeds the minimum requirement and therefore it is adequate.

B.9 References

B.9.1 24590-LAB-P1-60-00007, Rev. 002, ANALYTICAL LABORATORY GENERAL ARRANGEMENT PLAN AT EL (-) 19 FT - 2IN SECTIONS E-E, F-F & G-G.

B.9.2 24590-WTP-GPG-M-033, Rev. 004, Fire Water Floor Drain System.

B.9.3 24590-QL-SRA-MTF5-00001-44-00004, Rev. 00C, Drawing - Analytical Laboratory C5 Cell Details - 203.

B.10 Attachments

None