Spill Prevention Control and Countermeasure (SPCC) Plan

Multiple Horizontal Cylindrical Tanks Inside a Rectangular or Square Dike or Berm

WORKSHEET

This worksheet can be used to calculate the containment volume of a rectangular or square dike or berm for multiple horizontal cylindrical tanks. When there are other objects or structures such as tanks along with the largest tank within the dike or berm, their respective displacement volumes must be accounted for when determining secondary containment.

Steps:

1. Determine the volume of the secondary containment, V_{SC}

2a. Determine the volume of the tank when the tank shell capacity is unknown, V_{Tank}

2b. Determine the volume of the tank when shell capacity is known, V_{Tank}

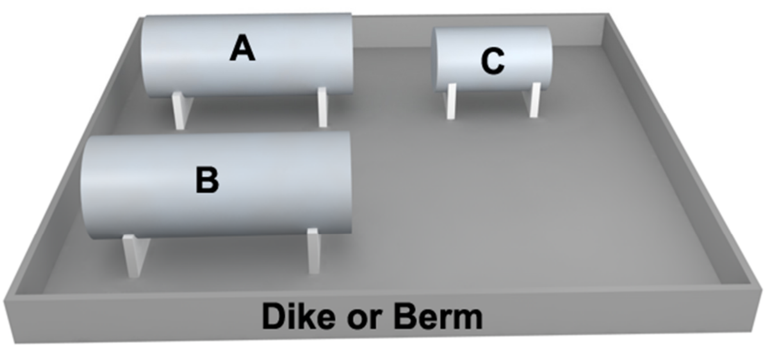
3. Determine the unavailable (displacement) areas and volumes in the containment due to other tanks within the containment and the net containment volume remaining for the largest tank

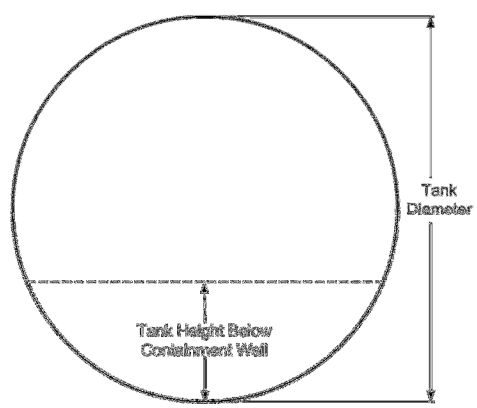
4. Determine the percentage of the net secondary containment volume, V_{SCNet}, to the largest tank volume, V_{Tank}

5. Determine whether the secondary containment can contain the entire tank shell capacity with additional capacity to contain rain.

Information needed to use this worksheet:

- Tank shell capacity in gallons or tank diameter and length of the largest tank in feet
- Secondary containment length, width, and height in feet
- Shell capacity in gallons or length and diameter of each of the other tanks in feet within the secondary containment
- Height in feet of each tank below top of containment wall
- If rain can collect in secondary containment: amount of rain, inches or feet, for the location





Largest Tank Shell Capacity (gal) = ____ **a**

Disclaimer: Please note that these are simplified calculations for qualified facilities that assume: 1) the secondary containment is designed with a flat floor; 2) the wall height is equal for all four walls; and 3) the corners of the secondary containment system are 90 degrees. Additionally, the calculations do not include displacement for support structures or foundations. For Professional Engineer (PE) certified Plans, the PE may need to account for site-specific conditions associated with the secondary containment structure which may require modifications to these sample calculations to ensure good engineering practice.

1. Determine the volume of the secondary containment, V_{SC}

Secondary Containment Area, A_{SC} = [ ] Length (ft) x [ ] Width (ft)

= [0] ft^2 **b**

V_{SC} (ft^3) = [ ] b (ft^2) x [ ] Height (ft) = [0] **c** ft^3

2a. Determine the volume of the tank when the tank shell capacity is unknown, V_{Tank}

Tank radius (ft) = [ ] Diameter (ft) ÷ 2 = [0] ft

V_{Tank} (ft^3) = 3.14 x [( )^2] Radius^2 (ft)^2 x [ ] Tank Length (ft) = [0] **d** ft^3

2b. Determine the volume of the tank when shell capacity is known, V_{Tank}

***a** is the tank shell capacity from page 1.*

V_{Tank} (ft^3) = [ ] a (gal) x 0.1337 ft^3/gal = [0] **e** ft^3

3. Determine the unavailable (displacement) areas and volumes in the containment due to other tanks within the containment and the net containment volume remaining for the largest tank

The easiest way to determine the displacement volume for a horizontal cylindrical tank is to use the tank manufacturer's liquid height to gallons conversion chart for the tank in Method 1 calculation. If this information is not available, use Method 2 calculation to obtain the displacement volumes.

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METHOD 1

Height of Tank B Below Containment Wall (in) = [ ] in

$V_{Tank\ B}$ Displacement (gal) From Tank Conversion Chart = [ ] gal
f

$V_{Tank\ B}$ Displacement (ft^3) = [ ] f (gal) x 0.1337 ft^3/gal = [0] **g** ft^3

Calculate the displacement of each additional horizontal cylindrical tank within the same secondary containment:

Total Displacement Volume (ft^3) = [ ] g (ft^3) + [ ] g1 (ft^3) + [ ] g2 (ft^3) + …

= [0] ft^3
h

METHOD 2

Height of Tank B Below Containment Wall (in) = [ ] in
i

Tank B Diameter (in) = [ ] Diameter (ft) x 12 in/ft = [0] in
j

Height to Diameter Ratio for Tank B = [ ] i (in) ÷ [ ] j (in) = [NaN]
k

Tank B Volume Fraction for Height to Diameter Ratio (Table) = [ ]
l

<u>If the tank shell capacity in gallons is known:</u>

Tank Volume $V_{Tank\ B}$ (ft^3) = [ ] Shell Capacity (gal) x 0.1337 ft^3/gal = [0] ft^3
m

METHOD 2 (CONT)

Or, if the tank shell capacity in gallons is not known:

Tank B radius (ft) = [ ] ÷ 2 = [0] ft
Diameter (ft)

$V_{Tank\ B}$ (ft^3) = 3.14 x [( )^2] x [ ] = [0] ft^3
Radius (ft) | Tank Length (ft) | **n**

Displacement, $V_{Tank\ B}$ (ft^3) = [ ] x [ ] = [0] ft^3
m (ft^3) | l | **o**

m *is the tank volume.*
l *is the Tank B volume fractionfor H/D ratio (table).*

Calculate the displacement of each additional horizontal cylindrical tank within the same secondary containment:

Total Displacement Volume (ft^3) = [ ] + [ ] + [ ] + **...**
o (ft^3) | o1 (ft^3) | o2 (ft^3)

= [0] ft^3
p

Net Secondary Containment Volume:

Net Containment Volume, V_{SCNet} (ft^3) = [ ] — [ ] = [0] ft^3
c (ft^3) | h (Method 1) or p (Method 2) (ft^3) | **q**

c *is the secondary contianment volume calculated in Step 1.*
h/p *is the total displacement volume.*

4. Determine the percentage of the net secondary containment volume, V_{SCNet} to the largest tank volume, V_{Tank}[1] (to determine whether the volume of the containment is sufficient to contain the largest tank's entire shell capacity).

Note: NaN = Not A Number. Once values **q** and **e** are inputted, NaN will be replaced with the correct value for **r**.

V_{SCNet}/V_{Tank} =		÷		=	NaN	
q *is the net secondary contianment volume calculated in Step 3, Method 2.* ***e*** *is the tank volume calculated in Step 2.*	q (ft^3)		e (ft^3)		**r**	
% =		x	100	=	0	
	r				**s**	

If percentage, **s**, is 100% or greater, the capacity of the secondary containment is sufficient to contain the shell capacity of the tank. If rain can collect in the dike or berm, continue to step 4. If percentage, **s**, is less than 100%, the capacity of the secondary containment is not sufficient to contain the shell capacity of the tank.

5. Determine whether the secondary containment can contain the entire tank shell capacity with additional capacity to contain rain.

If rain can collect in a dike or berm, the SPCC rule requires that secondary containment for bulk storage containers have additional capacity to contain rainfall or freeboard. The rule does not specify a method to determine the additional capacity required to contain rain or the size of the rain event for designing secondary containment. However, industry practice often considers a rule of thumb of 110% of the tank capacity to account for rainfall. A dike with a 110% capacity of the tank may be acceptable depending on, the shell size of the tank, local precipitation patterns and frequency of containment inspections. In a different geographic area, a dike or berm designed to hold 110% for the same size tank may not have enough additional containment capacity to account for a typical rain event in that area. The 110% standard may also not suffice for larger storm events. If you want to determine a conservative capacity for a rain event, you may want to consider a 24-hour 25-year storm event. It is the responsibility of the owner or operator[2] to determine the additional containment capacity necessary to contain rain. A typical rain event may exceed the amount determined by using a 110% "rule of thumb" so it is important to consider the amount of a typical rain event when designing or assessing your secondary containment capacity.

Rainfall data may be available from various sources such as local water authorities, local airports, and the National Oceanic and Atmospheric Administration (NOAA).

[1] Steps 4 and 5 in the worksheet determines whether the net volume of the secondary containment is sufficient to contain the largest tank's entire shell capacity and rainfall (freeboard for precipitation) as required by the SPCC rule. Step 4 primarily determines whether the net volume of the secondary containment is sufficient to contain the entire shell capacity of the largest tank. Step 5 is necessary to determine whether the secondary containment can also contain the expected volume of rainfall (both the volume of rain that falls into the containment plus the rain from the tank storage site).

[2] The SPCC rule does not require you to show the secondary containment calculations in your Plan. However, you should maintain documentation of secondary containment calculations to demonstrate compliance to an EPA inspector.

Selected Rainfall Event:

Rainfall (in) = [ ] in
t

Rainfall (ft) = [ ] ÷ 12
t (in) in/ft

[0] ft
u

Volume of Rain to be Contained, V_{Rain} (ft^3) = [ ] x [ ] = [0] ft^3
u (ft) b (ft^2) **v**

b *is the area of secondary containment calculated in Step 1.*

Total Containment Capacity Required (ft^3) = [ ] + [ ]
v (ft^3) e (ft^3)

e *is the tank volume calculated in Step 2.*

[0] ft^3
w

If the net secondary containment volume after accounting for displacements, **q**, is equal to or greater than the required containment capacity, **w**, the secondary containment is sufficient to contain the shell capacity of the largest tank with sufficient additional capacity to contain a typical rainfall amount. If the net secondary containment volume after accounting for displacements, **q**, is less than the required containment capacity, **w**, the secondary containment is not sufficient to contain the shell capacity of the largest tank and a typical rainfall amount.

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Table of H/D Ratios and Corresponding Percent of Tank Volume

"H" is the tank height below the top of the containment wall. "D" is the tank diameter.

H/D Ratio	Percent of Tank Vol	H/D ratio	Percent of Tank Vol	H/D ratio	Percent of Tank Vol
0	0	0.34	0.301	0.68	0.724
0.01	0.002	0.35	0.312	0.69	0.737
0.02	0.003	0.36	0.323	0.70	0.747
0.03	0.009	0.37	0.337	0.71	0.760
0.04	0.013	0.38	0.348	0.72	0.770
0.05	0.020	0.39	0.362	0.73	0.783
0.06	0.025	0.40	0.374	0.74	0.792
0.07	0.030	0.41	0.385	0.75	0.805
0.08	0.038	0.42	0.400	0.76	0.816
0.09	0.045	0.43	0.411	0.77	0.825
0.10	0.053	0.44	0.423	0.78	0.837
0.11	0.058	0.45	0.435	0.79	0.848
0.12	0.068	0.46	0.450	0.80	0.858
0.13	0.075	0.47	0.461	0.81	0.869
0.14	0.085	0.48	0.473	0.82	0.879
0.15	0.094	0.49	0.488	0.83	0.888
0.16	0.102	0.50	0.500	0.84	0.898
0.17	0.112	0.51	0.512	0.85	0.906
0.18	0.121	0.52	0.527	0.86	0.915
0.19	0.131	0.53	0.539	0.87	0.925
0.20	0.142	0.54	0.550	0.88	0.932
0.21	0.152	0.55	0.565	0.89	0.942
0.22	0.163	0.56	0.577	0.90	0.947
0.23	0.175	0.57	0.589	0.91	0.955
0.24	0.184	0.58	0.600	0.92	0.962
0.25	0.195	0.59	0.615	0.93	0.970
0.26	0.208	0.60	0.626	0.94	0.975
0.27	0.217	0.61	0.638	0.95	0.980
0.28	0.230	0.62	0.652	0.96	0.987
0.29	0.240	0.63	0.663	0.97	0.991
0.30	0.253	0.64	0.677	0.98	0.997
0.31	0.263	0.65	0.688	0.99	0.998
0.32	0.276	0.66	0.699	1.00	1.000
0.33	0.287	0.67	0.713		