Spill Prevention Control and Countermeasure (SPCC) Plan

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

EXAMPLE

This worksheet calculates the secondary containment volume of a rectangular or square dike or berm for three horizontal cylindrical tanks. In this example, displacements of the tanks except for the largest tank in the berm must be accounted for when determining the required secondary containment volume.

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}

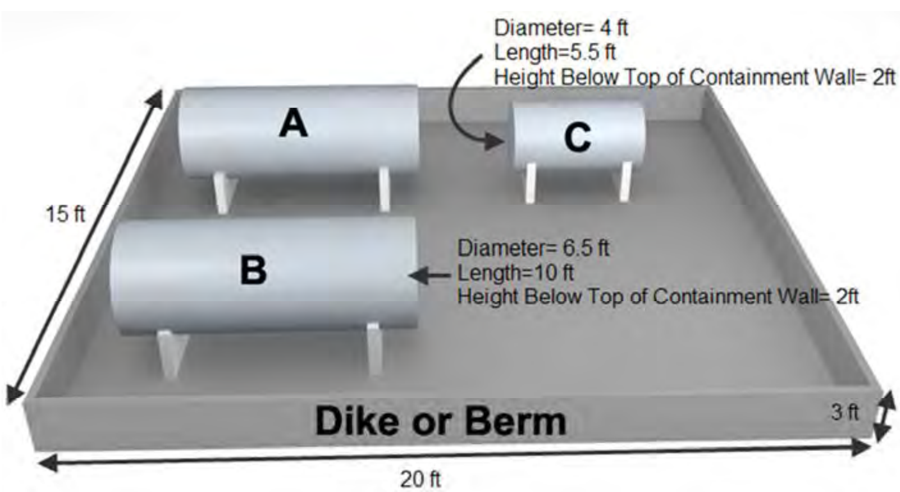
3. Determine the unavailable (displacement) areas and volumes in the containment due to other tanks within the containment and the net containment volume remaining for the largest tank

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
  Tanks A (off-road diesel) and B (on-road diesel) each has a shell capacity of 2,500 gallons while Tank C (gasoline) has a shell capacity of 500 gallons. Diameters and lengths of the tanks are as shown.
- Secondary containment length, width, and height
  See diagram for dimensions.
- Height of each tank below top of containment wall (except largest tank)
  See diagram for dimensions
- Rainfall amount
  Rainfall can collect in the secondary containment; the selected rain event for the location is 7 inches.



Largest Tank Shell Capacity (gal) = 2,500
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} = 20 Length (ft) x 15 Width (ft)

= 300 ft^2 **b**

V_{SC} (ft^3) = 300 b (ft^2) x 3 Height (ft) = 900 ft^3 **c**

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

Tank radius (ft) = 6.5 Diameter (ft) ÷ 2 = 3.25 ft

V_{Tank} (ft^3) = 3.14 x $(3.25)^2$ $Radius^2$ $(ft)^2$ x 10 Tank Length (ft) = 332 ft^3 **d**

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) = 2,500 a (gal) x 0.1337 ft^3/gal = 334 ft^3 **e**

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 in 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.

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 = [ ] **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) + …

= [ ] ft^3
h

METHOD 2

Height of Tank B Below Containment Wall (in) = 24 **i** in

Tank B Diameter (in) = 6.5 Diameter (ft) x 12 in/ft = 78 **j** in

Height to Diameter Ratio for Tank B = 24 i (in) ÷ 78 j (in) = 0.31 **k**

Tank B Volume Fraction for Height to Diameter Ratio (Table) = 0.263 **l**

If the tank shell capacity in gallons is known:

Tank Volume $V_{Tank\ B}$ (ft^3) = 2,500 Shell Capacity (gal) x 0.1337 ft^3/gal = 334 **m** ft^3

METHOD 2 (CONT)

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

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

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

Displacement, $V_{Tank\ B}$ (ft^3) = 334 x 0.263 = 88 ft^3
(m (ft^3) × l = **o**)

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

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

Height of Tank C Below Containment Wall (in) = 24 in (**i**)

Tank C Diameter (in) = 4 x 12 = 48 in
(Diameter (ft) × in/ft = **j**)

Height to Diameter Ratio for Tank C = 24 ÷ 48 = 0.50
(i (in) ÷ j (in) = **k**)

Tank C Volume Fraction for Height to Diameter Ratio (Table) = 0.5 (**l**)

Tank Volume $V_{Tank\ C}$ (ft^3) = 500 x 0.1337 = 67 ft^3
(Shell Capacity (gal) × ft^3/gal = **m**)

Displacement, $V_{Tank\ C}$ (ft^3) = 67 x 0.5 = 34 ft^3
(m (ft^3) × l = **o1**)

Total Displacement Volume (ft^3) = 88 + 34 = 122 ft^3
(o (ft^3) + o1 (ft^3) = **p**)

Net Secondary Containment Volume:

Net Containment Volume, V_{SCNet} (ft^3) = 900 — 122 = 778 ft^3
(c (ft^3) — p (Method 2) (ft^3) = **q**)

c *is the secondary contianment 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).

***q** is the net secondary contianment volume.*
***e** is the tank volume calculated in Step 2b of this worksheet.*

V_{SCNet}/V_{Tank} =	778	÷	334	=	2.33
	q (ft^3)		e (ft^3)		**r**
% =	2.33	x	100	=	233
	r				**s**

The percentage, **s**, is 233% which is greater than 100%. The secondary containment volume is sufficient to contain the shell capacity of the largest tank after accounting for the displacements. However, we must also account for rain that can collect in the dike or berm. See step 5.

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:

24— Hr 25— Yr

Rainfall (in) = 7 in
t

Rainfall (ft) = 7 ÷ 12
t (in) in/ft

0.6 ft
u

Volume of Rain to be Contained, V_{Rain} (ft^3) = 0.6 x 300 = 180 ft^3
u (ft) b (ft^2) **v**

Total Containment Capacity Required (ft^3) = 180 + 334
v (ft^3) e (ft^3)

514 ft^3
w

The net secondary containment volume after accounting for displacements in **q** is 778 ft^3, which is equal to or greater than the required containment capacity in **w**, which is 514 ft^3. Therefore, the secondary containment is sufficient to contain the shell capacity of the largest tank and has sufficient additional capacity to contain a typical rainfall amount.

The percentage of the net secondary containment volume to the largest tank shell capacity volume is 233% (**s** in Step 4). This percentage, which is greater than 100%, indicates that additional secondary containment capacity is available to contain rain as the containment is exposed to rain. Subtracting the largest tank shell capacity volume V_{Tank} of 334 ft^3 (**e** in Step 4) from the net containment volume V_{SCNet} of 778 ft^3 (**q** in Step 4) yields 444 ft^3 of additional containment capacity for rain. V_{Rain}, the volume of rain falling into the secondary containment in a 24-hour 25-year rainfall event that produces 7 inches of rain, is 180 ft^3 (**v** in Step 5). V_{Rain} is less than the 444 ft^3 of additional containment capacity by 264 ft^3; consequently, the additional secondary containment capacity is sufficient to also contain the rain from the selected rainfall event. As concluded at the end of Step 5 in this example, the net secondary containment volume is sufficient to contain the shell capacity of the largest tank and the selected typical rainfall amount.

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		