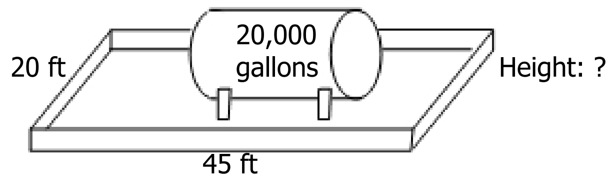
SPCC Plan - Calculation Guidance

The following example compares two different design criteria: one based on the volume of the tank and one based on precipitation.

Scenario:

A 20,000-gallon horizontal tank is placed within an engineered secondary containment structure, such as a concrete dike. The tank is 35 feet long by 10 feet in diameter. The secondary containment area provides a 5-foot buffer on all sides (i.e. dike dimensions are 45 feet x 20 feet).



Given the dike footprint, we want to determine the wall height necessary to provide sufficient freeboard for precipitation, based on (1) the tank storage capacity (2) actual precipitation data. Several storm events in the recent past caused precipitation in amounts between 3.6 and 4.0 inches at this location, although greater amounts have also been reported in the past.
Note: The factor for converting cubic feet to gallons is 7.48 gallons/ft^3

1. Calculation of secondary containment capacity, based on a design criterion of 110%* of tank storage capacity:**

Containment surface area = 45 ft x 20 ft = 900 ft^2
Tank volume, based on 100% of tank capacity = 20,000 gallons
Tank volume, in cubic feet = 20,000 gallons / 7.48 gallons/ft^3 = 2,674 ft^3
Wall height that would contain the tank's volume = 2,674 ft^3/ 900 ft^2 = 2.97 ft

Containment capacity with freeboard, based on 110% of tank capacity = 22,000 gallons
Containment capacity, in cubic feet = 22,000 gallons / 7.48 gallons/ft^3 = 2,941 ft^3
Wall height equivalent to 110% of storage capacity = 2,941 ft^3 / 900 ft^2 = 3.27 feet
Height of freeboard = 3.27 ft - 2.97 ft = 0.3 ft = 3.6 inches

Therefore, a dike design based on a criterion of 110% of tank capacity provides a dike wall height of 3.27 feet.

2. Calculation of secondary containment capacity, based on rainfall* criterion:**

After a review of historical precipitation data for the vicinity of the facility, it was determined that a 4.5 inch rain event is the most reasonable design criterion for this diked area.

Containment surface area = 45 ft x 20 ft = 900 ft^2
Tank volume, based on 100% of tank capacity = 20,000 gallons
Tank volume, in cubic feet = 20,000 gallons / 7.48 gallons/ft^3 = 2,674 ft^3
Wall height that would contain the tank's volume = 2,674 ft^3 / 900 ft^2 = 2.97 ft

The height of the dike would need to be 3.35 feet (2.97 ft + 4.5 in).

4.5 inches / 12 inches = .375 ft + 2.97 ft = 3.35 ft

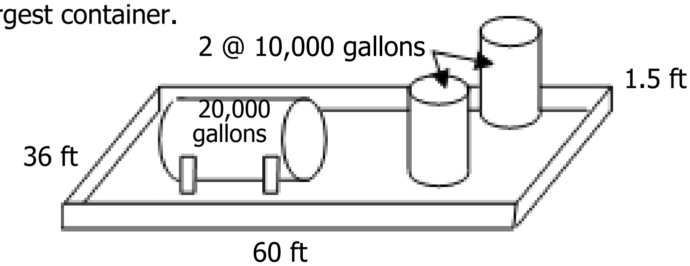
Therefore, a dike design based on a 4.5 inch rain event provides a dike wall height of 3.35, or 0.9 inch higher than calculated using the 110% criterion.

SPCC Plan - Calculation Guidance (continued)

Sample secondary containment calculations for multiple tanks in a containment area.

Scenario:

A 60 ft x 36 ft concrete dike surrounds one 20,000-gallon horizontal tank (10 ft diameter and 35 ft length) and two 10,000-gallon vertical tanks (each 10 ft diameter and 15 ft height). The dike walls are 18 inches (1.5 feet) tall. The SPCC Plan states that secondary containment is designed to hold 112% of the volume of the largest container.



Note: The volume displaced by a cylindrical vertical tank is the tank volume within the containment structure and is equal to the tank footprint multiplied by height of the concrete dike. The tank footprint is equal to ∏D2/4, where D is the tank diameter.

1. Calculate total dike capacity:

Total capacity of the concrete dike
= length x width x height = 60 ft x 36 ft x 1.5 ft = 3,240 ft^3 = 24,235 gallons

2. Calculate net dike capacity, considering displacement from other tanks within the dike:

The total capacity of the concrete dike is reduced by the volume "displaced" by other tanks inside the containment structure. The displacement is:
= number of tanks x footprint x height of dike wall
= 2 x ∏ (10 ft)^2/4 x 1.5 ft = 235.6 ft^3 = 1,762 gallons

The net dike capacity (i.e. the volume that would be available in the event of a failure of the largest tank within the dike) is:
= Total volume - tank displacement = 24,235 - 1,762 = 22,473 gallons = 3,004 ft^3

3. Calculate the amount of available freeboard provided by the dike, given the net dike capacity:

The available freeboard volume is:
= Net dike capacity - volume of largest tank within the dike
= 22,473 - 20,000 = 2,473 gallons = 331 ft^3

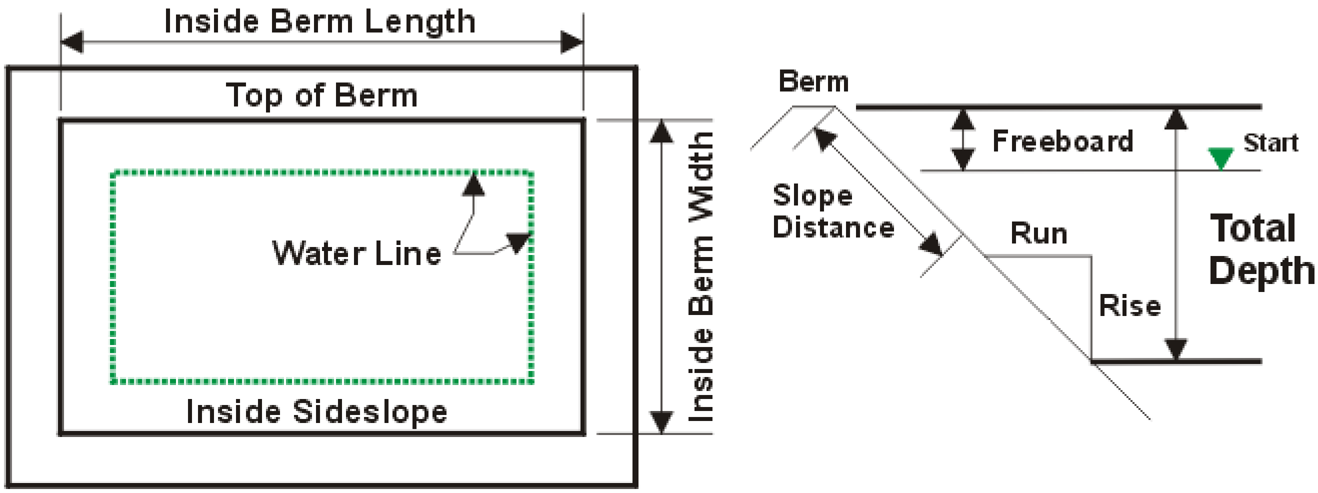
This is equivalent, expressed in terms of the capacity of the largest tank, to:
= Net dike capacity / volume of largest tank within the dike
= 22,473 / 20,000 = 112%

This available freeboard volume provides a freeboard height:
= Available freeboard volume / dike surface area
= 331 ft^3 / (60 ft x 36 ft) = 0.15 ft ≈ 1.8 in

Therefore, this dike provides sufficient freeboard for 1.8 inches of precipitation.

SPCC Plan - Calculation Guidance (continued)

The following guidance is offered as assistance in calculating the volume in gallons of capacity for earthen berms used for secondary containment structures.



1. **Calculate total berm capacity:**

    Total capacity of the berm
    = length (top of berm) x width (top of berm) x height (at lowest point)
    Top of berm: 60 ft x 36 ft x 1.5 ft = 3,240 ft^3 = 24,235 gallons (top)
    Bottom of berm: 54 ft x 30 ft x 1.5 ft = 2,430 ft^3 = 18,176 gallons (bottom)

    To determine average capacity: 24,235 + 18,176 divided by 2 = 21,205 gallons

2. **Calculate net dike capacity, considering displacement from other tanks within the berm:**

    Refer to and follow the instructions provided earlier in this guidance document.

3. **Calculate the amount of available freeboard provided, given the net berm capacity:**

    Refer to and follow the instructions provided earlier in this guidance document.

Conversions
1″ = .083′
2″ = .167′
3″ = .25′
4″ = .333′
5″ = .417′
6″ = .5′
7″ = .583′
8″ = .667′
9″ = .75′
10″ = .833′
11″ = .917′
12″ = 1′

SPCC Plan - Calculation Guidance (continued)

The following guidance is offered as assistance in calculating the volume in gallons of capacity for secondary containment structures and tanks.

Volume Formulas and Examples:

Floor capacity: **Length x Width x Height x 7.48 = Gallons of capacity**
Example: 20′ x 12′ x 2′ x 7.48 = 3,590 gallons

Tank capacity (round): **.7854 x Diameter x Diameter x Height x 7.48 = Gallons of capacity**
Example: .7854 x 6′ x 6′ x 12′ x 7.48 = 2,537 gallons

Tank capacity (cone): **.252 x Diameter x Diameter x Height x 7.48 = Gallons of capacity**
Example: .252 x 8′ x 8′ x 2′ x 7.48 = 241 gallons

Sloped Floor: **(Pyramid) .333 x Length x Width x Height x 7.48 = Gallons capacity**
Example: .333 x 30′ x 16′ x 6″ x 7.48 = 597 gallons

Sloped Floor: **(Trough) .333 x Length x Width x Height x 7.48 = Gallons capacity**
Example: .5 x 30′ x 16′ x 6″ x 7.48 = 897 gallons

*** Additional Considerations for Sufficient Freeboard

EPA recognizes that a "110 percent of storage tank capacity" rule of thumb may be a potentially acceptable design criterion in many situations, and that aboveground storage tank regulations in many states require that secondary containment be sized to contain at least 110 percent of the volume of the largest tank. However, in some areas, 110 percent of storage tank capacity may not provide enough volume to contain precipitation from storm events. Some states require that facilities consider storm events when designing secondary containment structures, and in certain cases these requirements translate to more stringent sizing criteria than the 110 percent rule of thumb. Other important factors may be considered in determining necessary secondary containment capacity. According to practices recommended by industry groups such as the American Petroleum Institute (API), these factors include:

- Local precipitation conditions (rainfall and/or snowfall)
- Height of the existing dike wall
- Size of container
- Safety considerations
- Frequency of dike drainage and inspection

Local precipitation data is available from the National Weather Service at:

http://www.nws.noaa.gov/oh/hdsc/currentpf.htm#N2

SPCC Plan - Calculation Worksheet