SPCC COMPLIANCE: DESIGN BUILD CONSIDERATIONS FOR SECONDARY CONTAINMENT

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St. Louis, Missouri
OVERVIEW

• Overview of Secondary Containment
  – Focus: Bulk Storage Tanks > 100,000 gallons
  – Earthen Dikes
  – Concrete Dikes
  – Steel Wall Systems

• Pre-Design
• Design
• Construction
• Example Projects
Pre-Design Considerations

• Existing Dikes
  – Assess existing containment capacity
  – Assess whether dike is sufficiently impervious
  – Inspect dikes prior to design

• New Containment
  – Evaluate available land and space limitations
  – Locate and map utilities
• Assess existing containment capacity
  – Calculating existing containment capacity using field measurements typically not reliable
  – Horizontal dimensions can be measured accurately, but vertical dimensions are potentially very inaccurate
  – Vertical dike height is only as good as the lowest elevation point on the top of dike (i.e., spill-over elevation)
  – For a 500’ x 500’ earthen dike, one vertical inch represents approximately 156,000 gallons
  – Hire a licensed surveyor to survey dike, determine existing spill-over location and elevation, and perform volume calculations
  – Topographic land surveys with calculations performed by CADD software (e.g., AutoCAD® Civil 3D®) significantly more accurate than field measurements and hand calculations
# Pre-Design

## Comparison of Surveys Vs. Field Measurements

<table>
<thead>
<tr>
<th>Site/Containment Area(s)</th>
<th>Hand-Measured Containment Volumes (gallons)</th>
<th>Survey Calculated Volumes (bbl)</th>
<th>Volume Difference (gal)</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SITE A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area 1 (Tank 864)</td>
<td>1,837,916</td>
<td>1,335,004</td>
<td>502,913</td>
<td>27.36%</td>
</tr>
<tr>
<td>Area 2 (Tank 896)</td>
<td>2,431,630</td>
<td>965,572</td>
<td>1,466,059</td>
<td>60.29%</td>
</tr>
<tr>
<td>Area 3 (Tanks 875, 114, and 655-50)</td>
<td>1,777,045</td>
<td>1,366,399</td>
<td>410,646</td>
<td>23.11%</td>
</tr>
<tr>
<td>Area 4 (Tank 880)</td>
<td>3,058,526</td>
<td>1,381,729</td>
<td>1,676,798</td>
<td>54.82%</td>
</tr>
<tr>
<td>Area 5 (Tank 865)</td>
<td>2,352,821</td>
<td>1,439,390</td>
<td>913,431</td>
<td>38.82%</td>
</tr>
<tr>
<td>Area 6 (Tank 867)</td>
<td>1,869,771</td>
<td>1,178,797</td>
<td>690,974</td>
<td>36.95%</td>
</tr>
<tr>
<td>Area 7 (Tank 875)</td>
<td>3,584,204</td>
<td>2,631,518</td>
<td>952,686</td>
<td>26.58%</td>
</tr>
<tr>
<td>Area 8 (Tank 877)</td>
<td>4,372,556</td>
<td>2,663,287</td>
<td>1,709,269</td>
<td>39.09%</td>
</tr>
<tr>
<td>Area 9 (Tank 878)</td>
<td>3,875,724</td>
<td>3,045,905</td>
<td>829,729</td>
<td>21.41%</td>
</tr>
<tr>
<td>Area 10 (Tank 879)</td>
<td>3,906,103</td>
<td>2,422,364</td>
<td>1,483,719</td>
<td>38.02%</td>
</tr>
<tr>
<td><strong>SITE B</strong></td>
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</tr>
<tr>
<td>Area 1 (Tanks 225, 345, 797, 1427, 6018, and 6019)</td>
<td>1,400,952</td>
<td>1,389,478</td>
<td>11,474</td>
<td>0.82%</td>
</tr>
<tr>
<td><strong>SITE C</strong></td>
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</tr>
<tr>
<td>Area 1 (Tank 855)</td>
<td>2,143,569</td>
<td>1,664,151</td>
<td>479,417</td>
<td>22.37%</td>
</tr>
<tr>
<td>Area 2 (Tank 858)</td>
<td>1,964,809</td>
<td>1,738,779</td>
<td>226,030</td>
<td>11.50%</td>
</tr>
<tr>
<td>Area 3 (Tanks 857)</td>
<td>2,886,680</td>
<td>1,913,470</td>
<td>973,211</td>
<td>33.71%</td>
</tr>
<tr>
<td>Area 5 (Tank 859 and 115)</td>
<td>2,511,724</td>
<td>1,926,128</td>
<td>585,596</td>
<td>23.31%</td>
</tr>
<tr>
<td>Area 6 (Tank 860)</td>
<td>1,993,817</td>
<td>1,531,281</td>
<td>462,536</td>
<td>23.20%</td>
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<tr>
<td><strong>SITE D</strong></td>
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</tr>
<tr>
<td>Area 1 (Tank 1446)</td>
<td>1,396,166</td>
<td>1,271,248</td>
<td>124,919</td>
<td>9.08%</td>
</tr>
<tr>
<td>Area 2 (Tank 1448)</td>
<td>1,415,407</td>
<td>1,319,191</td>
<td>96,217</td>
<td>6.80%</td>
</tr>
<tr>
<td>Area 3 (Tanks 1450)</td>
<td>1,394,276</td>
<td>1,011,457</td>
<td>382,819</td>
<td>27.46%</td>
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<tr>
<td><strong>SITE E</strong></td>
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<tr>
<td>Area 1 (Tanks 533 and 535)</td>
<td>386,235</td>
<td>342,636</td>
<td>43,599</td>
<td>11.29%</td>
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<tr>
<td><strong>SITE F</strong></td>
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<tr>
<td>Area 1 (Tanks 1510 and 1511)</td>
<td>1,862,868</td>
<td>1,308,901</td>
<td>553,967</td>
<td>29.74%</td>
</tr>
</tbody>
</table>
Pre-Design – Existing Dikes

• Inspect dikes prior to design
  – Earthen dikes: Look for signs of erosion, subsidence, animal activity (burrows, etc.) and whether dike is sufficiently impervious
  – Check for signs of distressed or sparse vegetation, or rooted plants
Animal burrowing can affect both the containment capacity and the structural integrity of the dike.

Rock covered dikes can help minimize animal burrowing.
Pre-Design – Existing Dikes

• Inspect dikes prior to design
  – Concrete dikes: Inspect for cracks
  – Pipe penetrations through dike walls should be sealed
Design Considerations

- NFPA 30 Requirements
- OSHA considerations
- Displacement volumes of smaller tanks
- Dike construction materials
- Space limitations & utilities
- Facility operations
- Pre-construction volume calculation
- Other considerations
• Tanks need to be accessible for firefighting purposes
  – Slope > 1% away for at least 50 ft. or to dike base
  – Outside base of dike must be at least 10 ft. away from property line
  – Dikes > 3 ft. in height shall have minimum 2-ft. wide crest, and slope of dike shall be consistent with angle of repose
  – Dikes containing 2 or more tanks should be divided by drainage channels or intermediate dikes to prevent spills from endangering adjacent tanks.
NFPA 30

Slope > 1%

Property Line > 10 ft.

2 ft. Minimum

Slope = Angle of Repose
• Confined Space Considerations
  – Does the containment have limited or restricted means of entry or exit?
  – Is the containment designed or configured for continuous occupancy?
  – Is the containment deeper than 4 feet?
• Area surrounding tank(s) shall be provided drainage or be diked
• Volumetric capacity (minus displacement volumes) must be greater than largest tank.
Tank C is largest tank. Displacement Volumes of A & B below spillover elevation must be deducted.

<table>
<thead>
<tr>
<th>Tank</th>
<th>Diameter (Feet)</th>
<th>Tank Height (Feet)</th>
<th>Tank Volume (Barrels)</th>
<th>Average Tank Base Elevation (Feet)</th>
<th>Dike Spillover Elevation (Feet)</th>
<th>Gross Dike Volume (Barrels)</th>
<th>Tank Displacement Volume (Barrels)</th>
<th>Net Dike Volume (Barrels)</th>
<th>Largest Max Fill Tank Volume (Barrels)</th>
<th>Containment Capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combined Tank Areas</strong></td>
<td></td>
<td><strong>Tanks A, B, and C</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>117</td>
<td>30</td>
<td>322,376</td>
<td>94.08</td>
<td>92.07</td>
<td>125,752</td>
<td>5,187</td>
<td>9,034 NA</td>
<td>111,531</td>
<td>79,704</td>
</tr>
</tbody>
</table>
Dike Construction Materials

- Dike walls should be “sufficiently impervious” and discharges should not escape the containment until cleanup occurs per Section 112.7(c).
- EPA does not specify permeability criteria…ultimately determination of imperviousness should be verified by the certifying P.E.
- Physical determination of sufficient imperviousness for existing dikes
  - Measure holding capacity after rain events
  - Inspect for exterior dike seeps
  - Underside of tanks – native soil testing and travel-time calculations, enhance integrity testing
  - Maintain calculations/engineering justifications on file
• Earthen floors may be acceptable if sufficiently impervious and there is no subsurface conduit to navigable waters.
  – Subsurface conduits (e.g., monitoring wells) should be sealed (leak tight caps, bentonite)
• Check State requirements regarding use of native soil as containment floor. Some states may restrict use or require laboratory geotechnical testing prior to approval.
Space Limitations and Utilities

- Completely map or survey available lands and utilities prior to design
- Consider locations of utilities during design
- Review locations of pipelines and on-site utilities with facility personnel
• Early and constant communication with facility is very important
• Design should not hinder normal plant operations
• Review conceptual design with facility prior to full design
### Volume Calculations/Other Considerations

- **Pre-construction Volume Calculation**
  - Apply “sufficient freeboard” to design – check State requirements
  - Verify your design with a volume calculation
  - Apply a factor of safety to the design elevation
- **Other Considerations**
  - Locate dike drains at topographic low point of containment floor
  - Winch post drainage pipe inlets should be higher than the spillover elevation
  - Concrete walls: Use a water stop at joints (should be compatible with product stored)
  - Squirt factor: Avoid designing dikes immediately adjacent to tank
Construction Considerations

- Pre-construction testing
- Site Preparation
- Soil placement and compaction
- Construction Quality Assurance (CQA)
- Post-construction Volumes Calculations
Construction Considerations

• Pre-construction testing
  – Earthen dikes: Proctor curve (moisture-density relationship) to determine optimum compaction
  – Earthen dikes: Re-molded permeability testing
  – Geomembranes: laboratory conformance testing
    • Pre-construction conformance testing per ASTM standards
      – Carbon black content
      – Thickness
      – Density
      – Tear and puncture resistance
• Site Preparation
  – Construct dikes on top of prepared subgrades (not gravel zones) to prevent seeps
  – Scarify subgrade prior to placement of soil
• Soil placement and compaction
  – Proper soil compaction should provide dike with sufficient strength and sufficient low permeability
  – Compact to at least 90% of the Standard Proctor (95% recommended)
  – Adjust moisture as needed to stay within acceptable range of optimum moisture content
  – Good engineering practice to achieve $1 \times 10^{-7}$ cm/sec permeability on dikes
Construction Considerations

- Construction Quality Assurance (CQA)
  - Recommend developing a CQA Plan prior to construction
  - Earthen dikes - Collect in-situ moisture/density tests using a nuclear gauge or equivalent to ensure you are meeting your compaction criteria
  - Concrete: cylinder tests for compressive strength
  - Geomembranes
    - Trial Welds
    - Non-destructive
      - Vacuum box
      - Air pressure testing for wedge welded seams
    - Destructive – laboratory peal and shear tests

- Post-construction survey and volume calculations (as-builts)
Example Projects

Capehart, Nebraska Pipeline Terminal
Earthen Dike and Retaining Wall
Final Construction Photos
Example Projects

Minneapolis/St. Paul Terminal
Combined Containment System: Earthen Dike and Geomembrane Lined Stainless Steel Wall
Minneapolis/St. Paul Terminal

Steel Wall Construction
Geomembrane liner placement

Sump system
Example Projects

Concrete Wall Systems – Topeka, KS and Waterloo, IA

Space limitations required construction of concrete wall to attain sufficient containment capacity

Topeka, KS ethanol tank

Existing earthen dike: insufficient capacity
Concrete wall constructed to accommodate space limitations (e.g., truck paths and utilities)
Waterloo, IA Terminal

Waterloo, IA concrete wall vertical extension project

Epoxy placed on top of existing wall

Concrete pouring activities

Completed wall extension
QUESTIONS?

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