DoD Standard Design for Vertical ASTs

Ms. Terri Regin, PE
27 April 2015
OVERVIEW

- Unified Facilities Criteria and ASTs
- New Features
- Tank Sizing & Layout
- Drawing Excerpts
- Tank Bottom & Roof
- Dike Area
- Questions
DoD Fuels Facilities Documents

- Unified Facility Criteria (UFCs)
  - Authoritative, mandatory unless waived by Service HQ

- Standard Designs (Std Dsn)
  - Starting point for design, edited for site adapt
    - Engineering Design is still needed
  - Identifies preferences and design choices
    - Includes designer notes
    - Lists which UFGS to be used
  - Major Deviations require Service HQ approval

- Unified Facilities Guide Specifications (UFGS)
  - Edited for the job
  - Designer choices in brackets
Unified Facilities Criteria (UFC)

- **UFC 3-460-01 Design: Petroleum Fuels Facilities**
  - Guidance for all new design and construction

- **Chapter 2 – General Design Information**
  - Fire protection, Safety
  - Environmental
  - Electrical Design & Area Classifications
  - Security
  - Emergency shutdown
Unified Facilities Criteria (UFC)

- Chapter 8 – Atmospheric Tanks
  - Tank Spacing
  - ASTs, vertical, horizontal,
  - USTs
  - Diking, spill containment
  - Vapor Emission Control systems
  - Tank Roofs, floating pans
  - Foundations, tank bottoms
  - Appurtenances
  - General Design Considerations

- Follows/directs use of NFPA 30, 30A
- Directs use of DoD Standard Design AW 78-24-27
# Specifications

<table>
<thead>
<tr>
<th>UFGS</th>
<th>Title</th>
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<tbody>
<tr>
<td>33 56 13.13</td>
<td>Steel Tanks With Fixed Roofs</td>
<td>May-2012</td>
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<tr>
<td>33 56 13.15</td>
<td>Undertank Interstitial Space</td>
<td>May-2012</td>
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<tr>
<td>33 56 63</td>
<td>Fuel Impermeable Liner System</td>
<td>Apr-2006</td>
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<tr>
<td>32 13 15.20</td>
<td>Concrete Pavement for Containment Dikes</td>
<td>Nov-2010</td>
</tr>
<tr>
<td>09 97 13.15</td>
<td>Low VOC Polysulfide Interior Coating of Welded Steel Petroleum Fuel Tanks</td>
<td>Feb-2015</td>
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<tr>
<td>09 97 13.27</td>
<td>Exterior Coating of Steel Structures</td>
<td>Feb-2010</td>
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</table>
AST Standard Design

- Vertical Steel Tanks in JP-5 or JP-8/F-24 Service
  - Can be used for other products
- For >5K, <100K BBL Vertical ASTs
- Fixed roof, floating pan
  - Considerations given for tanks w/o pans

- For new construction, but can be used for renovations
- Elevated and non-elevated foundations
  - Areas with/without high water tables
- Requires design in accordance with API 650
- For CONUS and OCONUS
History & Current Status

- Original Design in mid 80’s

- Update in Feb 1993
  - Shop drawing detailed
  - Only included Tank, not site layout

- Last Update Published in 2012
  - Rely more on API 650, prescribe government preferences

- Current Update 2015
  - Includes piping/dike details

- Will post to USACOE Std Dsn website
AST Standard Design

- Has sidestream filtration option
  - Fuel polishing, water drawoff

- Incorporates DLA ATG policy for gauge wells
  - Fuel level and water detection

- Includes 2 sheets designer notes
  - Use in corrosive and northern environments
  - Tank sizing and site planning
  - Foundation options
  - Tanks without floating pans
AST Standard Design

- Useable Volumes

- High/Low Level Control & Shutoff Logic

- Roof Structure, Compression Ring
  - Single column for diameters $126 \text{ ft} > D > 91 \text{ ft}$
  - No columns for diameters $< 91 \text{ ft}$

- UFC 3-460-01 Was Updated To Resolve Conflicts.
AST Standards Additions

- Typical Site Plans
- Piping Layout Plan
- Containment System Details
- Stairway Details
- Misc Piping Details
- Pipe Support Details
- Typical Electrical Details
Typical Site Plan – Vertical Containment Walls

DESIGN NOTES:
1. SITE PLAN SHOWN IS A TYPICAL 20K BBL TANK WITHOUT AN ELEVATED TANK FOUNDATION. DIMENSIONS SHOWN IN TABLE 1 ARE FOR PLANNING PURPOSES ONLY AND ARE INTENDED TO INDICATE THE APPROXIMATE AMOUNT OF AREA REQUIRED FOR SECONDARY CONTAINMENT.
2. FOR PLANNING PURPOSES, THE SECONDARY CONTAINMENT AREA SIZE SHOWN ON THE SITE PLAN IS BASED UPON A 5-Foot MAXIMUM ALLOWABLE HEIGHT VERTICAL DRAINWALL INCLUDING 1/2" OF FIBERGLASS WITH A WALL THICKNESS OF 1/8".
3. GROUPS OF TANKS, WITH NO TANK LARGER THAN 10K BBL AND NOT EXCEEDING 10K BBL IN AgGREGATE CAPACITY, MAY BE INTEGRATED INTO A SINGLE SECONDARY CONTAINMENT SYSTEM. SECONDARY WALLS BETWEEN TANKS SHALL BE OF MINIMUM 60 FEET IN HEIGHT FOR PROPER DRAINAGE AND DISTRIBUTION OF DRAINAGE. SECONDARY WALLS BETWEEN EACH TANK SHALL BE AT LEAST 50 FEET IN HEIGHT FOR PROPER DRAINAGE AND DISTRIBUTION OF DRAINAGE.
4. THE MAXIMUM ALLOWABLE WALL HEIGHT IS 60-Foot UCP 3650 requires a minimum of 12-Foot of freeboard. Vertical concrete containment walls are not acceptable alternative when there is not enough land available for the required freeboard. SECONDARY CONTAINMENT AREA DESIGN SHALL COMPLY WITH UCP 3650, 29 CFR 1910.119, NPMA 30 and OTHER FEDERAL, STATE, COUNTY, AND LOCAL REGULATIONS.
5. NO VEHICLE ACCESS IS PERMITTED WHEN VERTICAL DRAIN WALLS ARE IN USE.
6. SECONDARY CONTAINMENT SHALL BE PROVIDED BY A FUEL-INDEMNIBLEliner. THE LINER SHOULD BE A MEMBRANE-LIKE MATERIAL USED TO PREVENT LEAKING BY THE LAYER OF THE TANK. FUEL-INDEMNIBLELINERS SHALL BE CONFORM TO NPSA STANDARDS, AND REDUCE THE RELATIVE RISK OF A FUEL RELEASE. SECONDARY CONTENT WALLS SHALL BE DETERMINED BY ADDITIONAL CONSTRUCTION DETAILS.
7. CONCRETE DRAIN WALLS SHALL BE USED IN ACCORDANCE WITH THE SPECIFICATIONS SET FORTH IN UCP 3650.
8. SLOPE DRAIN WALLS ARE A MINIMUM OF 1:1 FOR DRAINAGE. DRAINAGE SWALES SHOULD BE SLOPED NO FLATTER THAN 6:1.
9. PROVIDE STEEL STAIRWAYS OVER THE TANK WALLS. NO LESS THAN TWO DUAL STAIRWAYS SHALL BE PROVIDED OVER WALLS FOR EMERGENCY ACCESS. SEE DETAILS ON SHEET C/12.
10. CONSTRUCT A CONTAINMENT DRAIN PIPE FROM THE DRAINAGE MINTER TO THE CONTAINMENT DRAIN VALVE USING DUCTILE IRON PIPE. A TYPICAL CONTAINMENT PLUG VALVE SHALL BE PROVIDED TO CONTROL DRAINAGE AND MUST BE ACCESSIBLE DURING A PREVAILING WIND SPEED OF 10 MPH.
11. PROVIDE FIRE HOSE STATION, CONSTRUCTION, AND FIRE HOSE STATIONS IN ACCORDANCE WITH UCP 3650.
12. PROVIDE FIRE HOSE STATION, CONSTRUCTION, AND FIRE HOSE STATIONS IN ACCORDANCE WITH UCP 3650.
13. FOR A TYPICAL RINGING LAYOUT PLAN SEE SHEET C/08.
14. FOR EXPOSED SITES, FIRE HYDRANTS SHOULD BE PROVIDED AT EXPECTED FOOT TRAFFIC PATTERNS. SEE UCP 3650 Section 3650b FUEL-INDEMNIBLELINER SYSTEM FOR DETAILS.

TYPICAL VERTICAL CONTAINMENT WALL SITE PLAN

TABLE 1

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1. NOMINAL TANK SIZE = APPROXIMATE SIZE. VOLUME = VOLUME IN LITERS TO UCP 3650.
2. SHEL VOLUME = VOLUME UNDER ALL OF THE SHELL.
3. DISTANCE IS MEASURED FROM THE OUTSIDE OF THE VERTICAL WALLS.
Non-Mounded Tank

Add photo of non-mounded tank
Typical Site Plan – Mounded Tank

DESIGNER NOTES:

1. SITE PLAN SHOWN IS A TYPICAL, 20K BLR. TANK WITH AN ELEVATED TANK FOUNDATION AND IS PROPOSED FOR GENERAL PLANNING PURPOSES ONLY. DIMENSIONS SHOWN IN TABLE 1 ARE FOR PLANNING PURPOSES ONLY AND ARE INTENDED TO INDICATE THE APPROXIMATE AREA REQUIRED FOR SECONDARY CONTAINMENT.

2. FOR PLANNING PURPOSES, THE SECONDARY CONTAINMENT AREA SIZE SHOWN HERE IS BASED UPON A 5’ HIGH TRAPEZOIDAL DKE BERM INCLUDING 1’ OF FREEBOARD. THE DKE SLOPES INDICATED ARE 1:1.5 T/O 1. THE DKE HEIGHT AND SLOPES SHOWN HERE ARE NOT STANDARD BUT ONLY AS ADJUSTED DUE TO ALLOW FLEXIBILITY IN PLANNING.

3. GROUPS OF TANKS, WITH NO TANK LARGER THAN 10K BLR. AND NO EXCEEDING 10K BLR. IN AGGREGATE CAPACITY, MAY BE ENCLOSURE IN A SINGLE DKE CONTAINMENT ENCLOSURE. SUBDIVIDE EACH DKE CONTAINMENT ENCLOSURE CONTAINING TWO OR MORE TANKS BY INTERMEDIATE WALLS OR DRYS NO LESS THAN 1’ IN HEIGHT TO REDUCE ENTRANCE AREA FOR EACH TANK. SEE SHEET JS01 FOR INTERMEDIATE WALL DETAIL.

4. UNSPACED AND AGGREGATE SURFACES SHALL BE SLOPE AT NO GREATER THAN 3:1. CONCRETE SURFACES SHALL HAVE A PREFERRED MAXIMUM SLOPE OF 2:1. T/O 1. WITH AN ABSOLUTE MAXIMUM SLOPE OF 1:1.5 T/O 1 WHEN SPACE IS RESTRICTED. A 3:1 SLOPE SURFACING IS REQUIRED ON THE TOP OF THE TRAPEZOIDAL BERM. THE MAXIMUM ALLOWABLE DKE BERM HEIGHT IS 8’ O.F. UCS 3.050’1 Requires a minimum 1’ of FREEBOARD, VERTICAL CONCRETE DKE WALLS ARE AN ACCEPTABLE ALTERNATIVE WHEN THERE IS NOT ENOUGH LAND AVAILABLE FOR TRAPEZOIDAL BERRS. SECONDARY CONTAINMENT WALLS ARE RECOMMENDED TO BE CONFORMANT WITH UCS 3.400-01, 20 CH 1110.15, MTA 30, AND OTHER FEDERAL, STATE, COUNTY, AND LOCAL REGULATIONS.

5. A CONCRETE ACCESS RAMP IS PERMITTED FOR 30K BLR. OR GREATER AST. VEHICLE ACCESS SHOULD BE STRICTLY CONTROLLED WITH A LOCKABLE BAR (I.E., CHAIN) GATE. A SLED. THE BAR SHOULD BE LOCKED TO AWORK three VEHICLES MUST BE LIGHT-DUTY AND RATED FOR USE IN CLASS I, II, IV, V, AND IX CONSTRUCTION ZONES. DESIGN DKE ACCESS RAMPS AND SLEDS TO WITHSTAND THE VEHICLE TRAFFIC. VEHICLE TRAFFIC SHALL NOT BE ALLOWED ON EXPOSED LINES.

6. SECONDARY CONTAINMENT SHALL BE PROVIDED BY A FUEL-RESISTANT LINER. THE LINER SHOULD BE A FLEXIBLE MEMBRANE LINER (F.M.). SEE TABLE 39 hurdles 3.01 FUEL-RESISTANT LINER SYSTEM. A 60 MIL HDPE POLYETHYLENE (H.P.E.) LINER MAY BE USED IF THE AREA IS COMPLETELY COVERED WITH CONCRETE. BALLAST MATERIAL, NEEDS TO BE PLACED TO PREVENT WIND-INDUCED DAMAGE TO THE LINER. BALLAST MATERIALS INCLUDE CONCRETE SURFACING, SMOOTH RIVER ROCK, SAND TUBES, AND PLYCONE CONCRETE BLOCKS. WIND UPLIFT CALCULATIONS ARE REQUIRED WHEN ANY PORTION OF THE PAL IS EXPOSED. SEE TABLE 35-56.01 FOR FURTHER GUIDANCE.

7. CONCRETE DKE SURFACING SHALL BE PER THE SECTION 32 11 12.20 CONCRETE PAVING FOR CONTAINMENT DERR. THE CONCRETE SURFACING SHALL BE PLACED IN LAYERS, STAGED AND JOINTS NOT GREATER THAN 1’ OF 125’ AND 1.5’ OF THE TANK BERM. (SEE SHEET JS01 FOR A TYPICAL JOINT LAYOUT PLAN.

8. SLOPE DKE BERM SURFACES A MINIMUM OF 1% FOR DRAINAGE. DRAINAGE SLOPES SHOULD BE SLOPED NO FLATTEN THE BERM DOWN TO THE DRAINAGE INLET. SEE SHEET JS01 FOR DRAIN DETAILS.

9. PROVIDE CONCRETE OR STEEL STAIRWAYS OVER THE DKE BERM. NO LESS THAN TWO DKE STAIRWAYS SHALL BE PROVIDED OVER EACH BERM ON WALKS FOR EMERGENCY ESCAPE. SEE DETAILS ON SHEET JS01 FOR WALKS.

10. CONSTRUCT A CONTAINMENT DRAIN LINE FROM THE DRAINAGE INLET TO THE DRAINAGE Outlet. USE DUCTILE IRON PIPING. A NORMALLY CLOSED, LOCKABLE ECCENTRIC PLUG VALVE SHALL BE PROVIDED TO CONTROL DRAINAGE AND MUST BE ACCESSIBLE DURING A FIRE. SEE DETAILS ON SHEET JS01 FOR DRAINAGE.

11. DO NOT USE BURIED DRAINAGE LINES IN CLIMATE WITH A DROUGHT. WIND-INDUCED DAMAGE TO THE LINER. BALLAST MATERIALS INCLUDE CONCRETE SURFACING, SMOOTH RIVER ROCK, SAND TUBES, AND PLYCONE CONCRETE BLOCKS. WIND UPLIFT CALCULATIONS ARE REQUIRED WHEN ANY PORTION OF THE PAL IS EXPOSED. SEE TABLE 35-56.01 FOR FURTHER GUIDANCE.

12. PROVIDE FIRE HYDRANTS TO PROTECT POLY STORAGE FACILITIES IN ACCORDANCE WITH UCS 3.400-01 & 3.400-01, INCLUDING A MINIMUM OF 1 HYDRANT TO PROTECT A MAXIMUM OF 500 FT OF PIPE. LOCATE HYDRANTS SUCH THAT ARTS CAN BE REACHED BY 150 FT OF SLOPE AT LEAST 3’ IN LENGTH. FIRE HYDRANTS MUST BE ACCESSIBLE TO FIRE DEPARTMENT FAMILIAR PERSONS.

13. FOR A TYPICAL PIPING LAYOUT PLAN SEE SHEET J.CS.

14. FOR EXPOSED GEOMIERNENT, SKEW-RESISTANT WALLS SHOULD BE PROVIDED ON EXPOSED ROAD PAVEMENT PATHS, INCLUDING THE TOP OF THE DKE. SEE LUGG SECTION 2 10 12 23 FUEL-RESISTANT LINER SYSTEM FOR MATERIALS.

**TABLE 1**

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<tr>
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<th>Nominal</th>
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NOMINAL TANK SIZE: APPROXIMATE USEABLE VOLUME = VOLUME FROM L.L.A. TO H.L.A.
APPROXIMATE VOLUME BETWEEN DUMP AND L.L.L.A.
VOLUME BETWEEN DUMP AND L.L.L.A.

Shell Volume = Volume Below All of the Shell.
Mounded Tank
# TABLE 1

<table>
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<th>NOMINAL TANK SIZE (KBBL)*</th>
<th>NOMINAL DIAMETER (FT)</th>
<th>NOMINAL SHELL HEIGHT (FT)*</th>
<th>FLOWRATE FILL/ISSUE (GPM)</th>
<th>NOZZLE SIZE FILL/ISSUE (INCHES)</th>
<th>SHELL VOLUME (KBBL)***</th>
<th>USABLE VOLUME (KBBL)</th>
<th>LLLA VOLUME (BBL)**</th>
<th>SECONDARY CONTAINMENT</th>
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* NOMINAL TANK SIZE = APPROXIMATE USABLE VOLUME = VOLUME FROM LLA TO HLA.
** APPROXIMATE VOLUME BETWEEN SUMP AND LLLA.
*** SHELL VOLUME = VOLUME INSIDE ALL OF THE SHELL.
NOTES:

1. SYSTEM SHALL BE FACTORY ASSEMBLED, SKID MOUNTED, FACTORY RUN.
2. PROVIDE ONLY CLASS 1, DIVISION 1, RATED ELECTRICAL COMPONENTS.
3. HEAT TRACE DRAIN PIPING (AND SLOW FILL PIPING TO FIRST VALVE) IN COLD CLIMATES.
4. PIPING ARRANGEMENT SHOWN IS CONCEPTUAL ONLY.
5. COORDINATE LOCATION OF CONCRETE HOUSEKEEPING PAD WITH PAVING JOINTS TO PREVENT CRACKING.

OPTIONAL SIDESTREAM FILTRATION SYSTEM

SCALE: 1/2"=1'-0"
NOTES:

1. See nozzle equipment schedule on Sheet 5.02 for size, elevation and orientation of nozzles and appurtenances.
2. Provide guardrail all around perimeter of roof except at stairway top platform.
3. Provide 8 x 8 opening in intermediate landing for piping and conduit.
4. Lap roof plate seams to shed water (inner plates on top).
5. See level set-point table A5/01/12 for elevations of alarms and controls.
6. Equipment not shown for clarity.
7. Space internal pipe supports for interior pipe support A5/02/08.
8. Provide a roof with slope between 1/2/12 and 2/12.

5K BBL TANK
SCALE: 1/8" = 1'-0"

5.01

GRAPHIC SCALE(S):

1/8" = 1'-0"
### 5K BBL Tank Nozzle/Equipment Schedule

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<th>ITEM</th>
<th>DESCRIPTION</th>
<th>SIZE (INCHES)</th>
<th>ANGLE (DEGREES)</th>
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### Notes
1. All dimensions shown on table for shell nozzles are measured from the bottom of the shell to the center of shell nozzles. All dimensions shown on table for roof nozzles are measured from the center of the tank to the circumference of roof nozzles. Dimensional value shown on table for sump bottom plate is measured from the center of the tank to the circumference of the sump.
2. All liquid level shell manholes to be separated and parallel with prevailing winds.
3. Provide a pan installation hatch on the fixed roof in accordance with the pan manufacturer's requirements.
4. All crosswall and roof manholes and piping must be designed by the designer. Refer to U.S. 1-1/2-01 for design information when sizing the pipes.
5. Adjust size of fill, issue and low suction nozzles to suit conditions such as distance to pumps and operational requirements.
6. Locate upper shell manhole 3-4" above upper surface of floating pan at high level position.
7. High level skimmer valve float assembly, as well as the high and high-low level alarm sensors, shall be accessible from the spiral stairway intermediate platform.
8. Mount the 4" ATG water probe well over the tank bottom sump through an 8" flanged roof nozzle for the indicated details.
9. The 4" water drain-off valve shown in this standard is based on the smallest double block and bleed valve available at the time this standard was written. For tanks that are expected to receive a minimum amount of water and are expected to produce minimum condensate, provide internal water drain-off pipe reduced to 1" size near the internal flange to limit the amount of water that is retained in the internal piping.
10. The elevation of fill and issue nozzle sizes 12" and larger shall be as low as allowed by the same 600 using low type reinforcing plates. Nozzle sizes smaller than 12" shall be as low as allowed by the same 600 using regular type reinforcing plates.
11. Floating pan low-level shall provide a minimum of 6" clearance from the top of any internal nozzle flanges to the bottom of the floating pan.
12. Provide at least one overflow for every 1,000 square feet of capacity. Do not locate overflows over sumps or shell drain-off valves. Where the pattern of roof permitted circulation vents would result in an overflow/circulation vent over product piping, the summary provide a shell circulation vent constructed similar to an overflow/circulation vent but 1/4" higher in elevation at that location and observe the remaining overflows are adequate.
13. Install low suction and water drain-off nozzles parallel to the issue nozzle.
14. All shell and roof nozzles shall be flanged unless otherwise indicated.
15. Internal piping for elevated tank foundation is shown on the elevated tank foundation, and internal piping plan, see 8/2/01.
16. Mount the 6" ATG and sample gauge wells through 10" flanged roof nozzles for the indicated details.
17. The minimum distance from the shell manhole reinforcing plate to the backside of the manhole flange, as measured horizontally on the vertical centerline, shall not be more than 6".
NOTES:
1. 10K BBL TANK IS SHOWN. OTHER TANK SIZES ARE SIMILAR.
2. TANK BOTTOM FOUNDATION SEAL FOR ANCHORED TANK SHOWN.
NOTES:
1. 10 KBB TANK IS SHOWN. OTHER TANK SIZES ARE SIMILAR.
2. TANK BOTTOM FOUNDATION SEAL FOR ANCHORED TANK SHOWN.

NON-ELEVATED RINGWALL

SCALE: 1"=1'-0"

GRAPHIC SCALE(S):
UFGS 33 56 63 Fuel Impermeable Liner System

- Flexible Membrane Liner (FML) or
- 60 Mil HDPE Liner
  - NOT Concrete Surface
  - NOT Clay / Bentonite

- Non-Woven Geotextile (Protective Layer)
- Walkway Materials (Slip-Resistant)
- Ballast Materials
  - Concrete
  - Gravel (River Rock)
  - Sand Tubes
  - Precast Concrete Block
Flexible Membrane Liner

- 30 mil Reinforced Liner with a 7.5 oz/sq yd Base Fabric Material
- Can be Exposed (with Ballast Material)
  - Wind Uplift Calculations are Required
  - Walkways are Required
HDPE Liner

- Non-Reinforced 60 mil High Density Polyethylene
- Susceptible to Thermal Expansion and Degradation from UV light
- Must be Completely Covered (Concrete or Gravel)
- Biggest Advantage is Economics
Liner Joints and Testing
Typical Dike Area Joint Layout Plan

DESIGNER NOTES:
1. JOINT LAYOUT PANELS SHOULD BE AS CLOSE TO SQUARE AS POSSIBLE WITH A MAXIMUM JOINT SPACING OF 10 FEET.
2. EXPANSION JOINTS SHALL BE PLACED AROUND THE TANK FOUNDATION AT THE OKE FOOTERS; ON EACH SIDE OF THE CONCRETE STAIRWAYS, AT THE AREA INLET; AND AT THE QUARTER SECTIONS OF THE BASIN, AS INDICATED.
3. ODD SHAPED PANELS SHALL BE REINFORCED WITH WRF.
4. GROWTH ELEVATIONS SHALL BE PROMPTED AT THE LOCATIONS INDICATED AND AT OTHER APPLICABLE CHANGE OF GRADE POINTS.
5. THE TOP OF THE TANK FOUNDATION SHALL BE ONE FOOT ABOVE THE CONTAINMENT BASIN, AS INDICATED.
6. PROVIDE POSITIVE DRAINAGE AWAY FROM THE TANK FOUNDATION PERIMETER.
7. PROJECT SPECIFICATIONS SHALL USE UFC 02-02-18-15-25 CONCRETE PAVEMENT FOR CONTAINMENT DISS.

JOINT DETAIL A
SCALE: NONE

JOINT DETAIL B
SCALE: NONE

LEGEND:
- CONTRACTION JOINT
- EXPANSION JOINT
- DRAINAGE SWALE
- REINFORCED CONCRETE PER CO. 22
- FLOW DIRECTION
- SPOT ELEVATION
Concrete Surfacing

- UFGS 32 13 15.20 Concrete Pavement for Containment Dikes
- 10’ Maximum Joint Spacing
- Synthetic Fiber Reinforcement
- Steel Reinforcement Discontinuous at Joints
- NOT Considered a Fuel Impermeable System on it’s Own
Concrete Dikes
Dike Details – Concrete Surfaced

**Typical Section - Spill Containment Dikes**

General Notes:
1. All concrete shall be reinforced with synthetic fiber reinforcement. Additional steel reinforcement shall be provided, where indicated on the joint layout plan. See specifications section 32 13.5.6 for concrete pavement for containment dikes for concrete and reinforcement requirements.

2. Provide a geomembrane boot for all circular geomembrane penetrations. All small liner penetrations shall be circular to accommodate a boot seal.

3. All joints shall be sealed per specifications section 32 13.18.19 for field molded sealants for sealing joints in field pavements. See sheet 12 for the joint layout plan.

4. A geotextile shall be installed below and above the geomembrane. See specification section 32 56.63 for fuel impermeable liner system. The geomembrane and geotextile shall be protected from damage at all times, as specified.

5. The surface underlying the geotextile/geomembrane shall be smooth and free of rocks larger than 3 inch diameter or any other material which could damage the geomembrane liner.

6. Geomembrane anchorage/encapsulation strip materials and installation shall be as recommended by the manufacturer of the geomembrane.

**Typical Liner Section**

Dikes Interior and Basin (W/ Liner)

Dike Exterior (W/O Liner)

**Designer Notes:**

1. Geotextile layers are provided to protect the geomembrane during and after construction. The bottom geotextile layer may be omitted if the subgrade soil is known to be free of rocks or other materials that could potentially damage the geomembrane.

2. See sheet 12.08 for RPR penetrations over 12 inches in diameter.
Dike Details – Concrete Surfaced

Typical Dike Corner Reinforcement Detail

Slab Reinforcing Detail

Concrete Footing Detail

Expansion Joint Detail

Construction Joint Detail

Contraction Joint Detail

Completed Construction Joint Sealant Detail

Completed Expansion Joint Sealant Detail

Completed Contraction Joint Sawcut Details
Dike Details – Exposed Liner

**Typical Section - Spill Containment Dikes**

**Scale: None**

**General Notes:**
1. All concrete shall be reinforced with synthetic fiber reinforcement. Additional steel reinforcement shall be provided, where indicated, on the joint layout plan. See specifications section 32 16-20 for concrete pavement for containment dikes for concrete and reinforcement requirements.
2. Provide a geomembrane boot for all circular geomembrane penetrations. All small liner penetrations shall be circular to accommodate a boot seal.
3. All concrete joints shall be sealed per specifications section 30 16-19. Field molded sealants for sealing joints in rigid pavements. See sheet CD 04 for the joint layout plan.
4. A geotextile shall be installed below and above the geomembrane where covered with concrete. A geotextile shall be installed below the geomembrane where the geomembrane is exposed on the surface. See specification section 33 59 63 for impermeable liner system. The geomembrane and geotextile shall be protected from damage at all times as specified.
5. The surface underlying the geotextile/geomembrane shall be smooth and free of rocks larger than 1/8" in diameter or any other material which would damage the geomembrane liner.
6. Geomembrane anchorage or embedment strip materials and installation shall be as recommended by the manufacturer of the geomembrane.
7. Rock material shall be clean, well graded 5/8" to 1-1/2" river rock. The rock layer shall be compacted with two passes of a walk behind vibratory roller.
8. A skid resistant walkway shall be provided along the foot of the dike walk path and on pathways within the tank basin, as indicated on the site plan. See specification section 33 59 63 for fuel, impermeable liner system, for walkway materials.
9. Sands tubes shall be provided on the exposed geomembrane for ballast to prevent wind uplift. See specification section 33 59 63 for fuel, impermeable liner system for additional details.

**Designer Notes:**
1. The geotextile layers are provided to protect the geomembrane during and after construction. The bottom geotextile layer may be omitted if the substrate soil is known to be free of rocks or other materials that could potentially damage the geomembrane.
2. Other ballast materials may be specified. Wind uplift calculations must be performed regardless of the ballast materials used. Specification section 33 59 63 fuel, impermeable liner system provides wind uplift design guidance.

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Dike Exterior Walls (W/O Liner)**

**Scale: None**

**Typical Conduit or Small Pipe Penetration Detail**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**

**Typical Liner Section**

**Concrete Working Surface**

**Scale: None**
Walkway / Sand Tubes
Precast Block Walkways/Ballast
Liner Fastening Details

TYPICAL GEOMEMBRANE TERMINATION DETAIL - EXISTING STRUCTURE

TYPICAL GEOMEMBRANE TERMINATION DETAIL - NEW STRUCTURE

NOTE: GEOMEMBRANE INSERT TO BE MANUFACTURER'S STANDARD

CONCRETE STRUCTURE INTERFACE DETAIL - EXISTING STRUCTURE

CONCRETE STRUCTURE INTERFACE DETAIL - NEW STRUCTURE

CONCRETE STRUCTURE INTERFACE DETAIL - EXISTING STRUCTURE

CONCRETE STRUCTURE INTERFACE DETAIL - NEW STRUCTURE

DESIGNER NOTES:

1. THE GEOMEMBRANE LAYERS ARE PROVIDED TO PROTECT THE GEOMEMBRANE DURING AND AFTER CONSTRUCTION. THE BOTTOM GEOTEXTILE LAYER MAY BE OMITTED IF THE SUBGRADE SOIL IS KNOWN TO BE FREE OF ROCKS OR OTHER MATERIALS THAT COULD POTENTIALLY DAMAGE THE GEOMEMBRANE.
Liner Termination Details

CONCRETE STRUCTURE (I.E. TANK FOOTING)

FUEL RESISTANT SEALANT

3/8" x 2" ALUMINUM OR 1/4" x 2"
SS STRIP W/ SLOTTED HOLES

3/8" SS EXPANSION ANCHOR
@ 12" O.C.

SS WASHER & NUT

3/8" X 2" NITRILE GASKETS

GEOMEMBRANE

NOTE: VARIANCES TO THIS DETAIL MAY BE MADE WHEN RECOMMENDED BY THE GEOMEMBRANE MANUFACTURER.

TYPICAL GEOMEMBRANE TERMINATION DETAIL - EXISTING STRUCTURE

SCALE: NONE

CONTINUOUS GEOMEMBRANE INSERT

EXTRUSION WELD

NOTE:
GEOMEMBRANE INSERT TO BE MANUFACTURER'S STANDARD

TYPICAL GEOMEMBRANE TERMINATION DETAIL - NEW STRUCTURE

SCALE: NONE
Embed Strips
Concrete Stairway Details

Concrete Stair Plan

Table of Stair Dimensions

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NOTES:
1. Pipe Handrail shall have welded ground smooth and be hot dipped galvanized after fabrication.
2. Per ADA guidelines, treads shall have a minimum width of 11" and a maximum height of 7" as measured from riser to riser.
3. Handrails shall be exposed galvanized unless painted, rails are required by the installation. If painting is required, the rails should still be galvanized before painting.

Designer Notes:
1. Per BE and ADA guidelines risers have a minimum height = 4" and a maximum height of 7".
2. Per ADA guidelines, treads shall have a minimum width of 11".

Section:

Plan:

Elevation:

Base Plate Detail:

Stair Detail:

Concrete Stairway Details
Containment Wall Details

Typical Section - Spill Containment Walls

Typical Section - Spill Containment Intermediate Wall

Wall Control Joint Detail

Basin Floor Large Pipe Penetration Detail

Concrete Wall Penetration Detail
Basin Floor Penetration Detail

Note: For pipes 2" in diameter or less, see detail on sheet CD.01.

Basin Floor Large Pipe Penetration Detail

Scale: None
Containment Wall Penetration Detail
Containment Wall Penetration
Containment Wall Control Joint
Containment Drainage Details

Type X Area Inlet Plan

Section

Inlet Construction General Notes:
1. Standard construction shall be cast in place reinforced concrete. Precast construction shall not be allowed.
2. Reinforcing steel, fy = 80 ksi.
3. Minimum clear cover of concrete over reinforcing steel shall be 3 inches for concrete placed against the soil.
4. Cast iron grate and frame shall be heavy-duty mesh/1.25 in. or light-duty mesh/1.125 in. (not subjected to possible wheel loads), or approved equal.
5. Minimum 6" compacted (95%) subgrade required under inlets.

Section

Containment Drain Valve Detail

Scale: None
Inlet Section

WEEP DRAIN (2 EA), 1-1/2" DIA.
HDPE WITH END CAP.
BLANKET WITH GEOTEXTILE
PRIOR TO PLACEMENT OF
ROCK BALLAST

1/2" PERFORATIONS, 1" O.C.

6" NITRILE WATERSTOP
(TYP. ALL SIDES)

D VARIES
SEE PLANS

SLEEVE W/ WATERSTOP

GRATE AND FRAME

#4 @ 12" O.C. EACHWAY
EXTRUSION WELD

ROCK BALLAST
GEOTEXTILE
FUEL IMPERMEABLE
GEOMEMBRANE LINER
GEOTEXTILE

(2) - #5 x 1'-0"
AROUND PIPE

DIP
NITRILE BOOT SEAL W/ SS CLAMPS
SEGMENTED ELASTOMERIC
SEAL (TYP. OF 2)

(2) - #4 EACH WAY

SECTION 3
Precast Inlet
Containment Drain Valve Detail

NOTE: 100% PORT ECCENTRIC PLUG VALVE SHALL CONFORM TO AWWA C517 AND BE RESISTANT TO HYDROCARBONS (NITRILE RUBBER SEALS). GEAR ACTUATOR BOX WITH HANDWHEEL SHALL BE LOCKABLE.
Typical Piping Layout

DESIGNER NOTES:
1. LOCATION AND CONFIGURATION SHOWN FOR PIPING IS GENERAL AND IS NOT INTENDED TO LIMIT OR RESTRICT PIPING LOCATION, CONFIGURATION OR PIPE SUPPORT ARRANGEMENT.
2. PIPE SUPPORT TYPES SHOWN ARE TYPICAL. IN GENERAL, WITHIN CONTAINMENT BUILDINGS THE FIRST SUPPORT WHICH IS AN ANCHOR SUPPORT, USE OF AN ADJUSTABLE PIPE HANGER SUPPORT (SEE SHEET CD 11) OR FREE SUPPORT (SEE SHEETS CD 12 & CD 13) IS COMMON. ON THE PEAK OF THE DWELL, USE OF A GUIDED SUPPORT (SEE SHEETS CD 12 & CD 13) IS COMMON. ACTUAL PIPING LAYOUT, SITE CONDITIONS, RESULTS OF PIPE STRESS ANALYSES, AND HYDRAULIC TRANSIENT ANALYSES SHALL Dictate ACTUAL SUPPORT TYPES AND LOCATIONS.
3. PROVIDE BALL JOINT. BALL JOINTS MAY BE USED IN EXTREME NORTHERN CLIMATES (E.G. ASKARL) PROVIDED SUBMERSIBLE SEAL MATERIALS FOR LOW TEMPERATURES ARE SPECIFIED. A PAIR OF BALL JOINTS SHOULD BE PLACED INTO THE PIPING RUN AND SHALL BE A MINIMUM OF 1.5 METERS APART. PLACE A THIRD BALL JOINT INTO THE PIPING RUN SUCH THAT LINEAR MOVEMENT FROM THE PIPING WITH THE TWO BALL JOINTS DUAL SUPPORT SYSTEM IS NON EXISTENT. BALL JOINTS SHOULD BE MOUNTED IN PIPING RUNNING PERPENDICULAR TO THE PIPING WITH THE TWO BALL JOINTS SEPARATED BY 12 INCHES. USE FLEXIBLE BALL JOINT DETAIL ON SHEET CD 11.
4. AT LOCATIONS EXPERIENCING FREEZING CONDITIONS, ALL CRAIN PIPING ON THE PRODUCT SIDE TANK AND FILTER SEPARATION. IF PIPE SUPPORTS ARE USED DRAW WITH APPLICABLE HAZARD RATED TAPE AND INSULATED.
5. LOCATE EXTERIOR PIPING SUPPORT TO PROVIDE ADEQUATE PIPE FLEXIBILITY FOR TANK SETTLEMENT, SEISMIC DESIGN AND THERMAL EXPANSION. EXCEPT FOR THE FIRST PIPE SUPPORT OF THE TANK SHELL, SPRAY PIPING SUPPORTS MAY BE USED IN HIGHER SEISMIC ZONES. SUPPORTS MAY BE PLACED DIRECTED BY SERVICE HEADQUARTERS. SEE DETAIL ON SHEET CD 13.
6. IN LOCATIONS SUBJECT TO ICE AND SNOW, ORIENT SCAFFOLDS AND HIGH LEVEL PIPING TO RECEIVE WINTER SUN SO AS TO MELT ACCUMULATIONS. IF PIPING AT TANKS IS NOT BELOW A SCAFFOLD, PROVIDE ICE SHELVES OVER PRODUCT PIPING AND VALVES AT TANK. ENSURE ICE SHELVES HAVE SUFFICIENT CLEARANCE ABOVE VALVES TO ALLOW MAINTENANCE OF VALVES AND VALVE OPERATIONS OR PROVIDE MEANS TO MOVE SHELVES OUT OF THE WAY AND PROVIDE CANOPIES OVER OTHER VALVES AND EQUIPMENT.
7. PIPING DESIGN SHALL ADDRESS SEISMIC. THE FIRST PIPE SUPPORT OF THE TANK SHALL BE AN ANCHOR WITH THE CONCRETE PIER TIED TO THE SKELETON.
Pipe Support Notes & Details

**Concrete Notes**
1. Cast-in-place concrete shall conform to American Concrete Institute "Building Code Requirements for Structural Concrete," ACI 318.
2. Specified compressive strength: $f_c = 3.000$ psi at 28 days typ.
3. Reinforcing materials:
   - Reinforcing bars shall conform to ASTM A615 or ASTM A302, grade 60.
   - Lap splices and concrete cover of reinforcement shall conform to ACI 318 using class B tension splices unless otherwise noted.
4. Reinforcing bars shall be supported at 2'-0" C.C. each way, max.
5. All reinforcing steel, and embedment items such as anchor rods and weld plates shall be accurately placed in the positions shown and absolutely tied and supported before concrete is placed to prevent displacement beyond permitted tolerances.
6. Details shall conform to ACI detailing manual, publication SP-49, ACI 318, and ACI 350.
7. Provide accessories necessary to properly support reinforcing at positions shown on drawings.
8. Exposed edges of concrete shall be chamfered 1/8".
9. Clean cover for reinforcing for cast-in-place concrete shall be as follows:
   - Concrete cast against or permanently exposed to earth: 3/8".
   - Concrete exposed to earth or weather:
     - No. A through No. 10 bars: 2".
     - No. 12 bars, No. 12H bars, and smaller: 1 1/2".
   - Concrete not exposed to weather or in contact with ground:
     - Slabs, walls, columns (primary reinforcement and stirrups): 1 1/2".
10. Coefficient of friction: $f = 0.60$.

**Carbon Structural Steel**
2. Wide flange shapes shall conform to ASTM A922, $F_y = 50,000$ psi.
3. Rolled plate and shapes shall conform to ASTM A36, $F_y = 36,000$ psi.
4. Structural tubulars shall conform to ASTM A500, grade B, $F_y = 48,000$ psi.
5. Anchor bolts shall conform to ASTM A325, $F_y = 36,000$ psi.
6. Welding shall conform with specification 33.55.43.13.
7. Do not weld carbon steel plates or tees to stainless steel pipe.
8. Do not weld galvanized carbon steel plates or tees to stainless steel or carbon steel pipe.

**Soil & Foundation Notes**
- Max allowable net soil bearing pressure, $P\times X\times X$, psi.
- One-third overstress may be allowed for temporary wind or seismic loading.
- Lateral bearing pressure, $P\times X\times X$ psi below finished grade.
- Friction angle, $\phi = X\times X\times X$.
- Lateral earth pressure coefficients:
  - Active: $K_a = X\times X\times X$.
  - At-rest: $K_r = X\times X\times X$.
  - Passive: $K_p = X\times X\times X$.
- Coefficient of friction: $f = X\times X\times X$.
- Pile penetrometer: $P\times X\times X\times X$. 

**Typical Pier Detail - Centerline**
Elevation less than 3'-0" above grade.
Scale: 1/8"=1'-0"
Typical Electrical Details

1. Storage Tank Electrical Elevation
   - Scale: None
   - Designer Note:
     1. If electronic type level alarms are to be used instead of the mechanical float type indicated on the storage tank electrical elevation detail, modify the detail with requirements appropriate to the electronic level alarms.
     2. If an ATS system other than the one depicted is used, the storage tank electrical elevation detail shall be modified to include proper conductors and conductors for that type of ATS system.

2. Emergency Fuel Shut-Off
   - 1.2" x 1.2" to Next EPDS except last in series
   - Red letters, white field

3. Caution Sign Detail
   - Scale: None

4. Exterior Fuel Piping Hazardous Area Detail
   - Scale: None
   - NEMA 4x hermetically sealed for Class I, Div 2
   - Junction box as required, size per NEC
   - Conduit seal-off (TP)

5. Fuel Storage Tank Hazardous Area Detail
   - Scale: None
   - Class I, Division 1, Group D (T20)
   - Class I, Division 2, Group D (T20)
   - Any below grade depression

6. Notes:
   1. See tank drawings for exact location of level switches and product return pump.
   2. Weld conduit support structures (as required) to tank wall.
   3. Remote EPDS station to be placed immediately outside of containment area. See this sheet for details.
   4. Cathodic protection terminal cabinet to be placed outside of containment and hazardous areas. It may be located immediately outside of containment area or near rectifier. See sheet ED.01 for details.
Criteria Libraries

- UFCs and Specifications (UFGSs) available at: The Whole Building Design Guide
  http://www.wbdg.org

- Standard Designs available at:
  http://www.hnd.usace.army.mil/stddgn/
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