Calculation Cover Sheet

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| Computer Program         | N/A                                   |

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Version/Release No.: N/A

Purpose and Objective

Evaluate the Type IV Tanks '18 and '19 for tank structural integrity, reducing grout and intruder grout stress levels, and foundation pressures throughout Tanks 18 and 19 grouting activities.

Summary of Conclusion

See Section 5.0 for a summary of results and conclusions for the evaluations performed in this calculation. The table in Section 5.11 summarizes the grout and concrete compressive strength and stresses.

Revisions:

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<td>Document Review</td>
<td>Wade Faires</td>
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<td>William Kennedy</td>
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Design Authority - (Print) JOHN J. PHILLIPS Signature

Release to Outside Agency - (Print) N/A Signature

Security Classification of the Calculation: Unclassified

USQ-FTF-2006-00216
Calculation Continuation Sheet

Record of Revisions

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APPENDICES

APPENDIX A .................. A1, A2
1.0 **INTRODUCTION**

This calculation provides documentation for tank structural integrity, reducing grout and intruder grout stress levels, and foundation pressures throughout Tank 18 and Tank 19 closure activities. *(See Appendix A)*

2.0 **Scope**

2.1 The calculations would establish procedural requirements to maintain tank structural integrity during the grouting process.

2.2 Establish the compressive stress adequacy of the reducing grout at critical stages of the grouting process and at completion of backfill.

2.3 Establish the compressive stress adequacy of the intruder grout at the completion of backfill.

2.4 Establish the compressive stress adequacy of the flexible base slab at the completion of backfill.
2.5 Consider the following engineered backfill scenarios:

1. Backfill to the level of the riser cover at the dome apex.

2. Backfill to the level 10 ft. above 1.

3. Backfill to grade level west of tank 17 through 20.

4. Backfill to the level 10 ft. above the top of evaporator 3LDS. 242°F.

2.6 The calculation will provide the highest soil bearing pressure under the appropriate backfill scenario. The calculated soil pressure does not include the weights of earthmoving equipment since these loads are temporary and have no bearing on long-term settlement.

2.7 The increased soil bearing pressure is evaluated by SRS Site Geotechnical for ultimate settlement after tank closure.
3.0 Methodology/Assumptions/Input

3.1 The maximum grout pour rate is 75 cu. yd. per hr which is equal to the batch plant production rate. This rate is used to establish grout volume vs time in the calculations such as the time it would take to pour reducing grout that would load the flexible base slab to the specified allowable soil bearing pressure and the time it would take to pour reducing grout to a depth such that the grout fluid pressure would balance the surrounding at-rest lateral soil pressure. These conditions would allow grout pour to continue without additional consideration for the integrity of the tank flexible base slab and tank wall.

3.2 Check grout pour continuity for the reducing grout up to the dome springline by sufficient grout strength using the volume vs time relationship mentioned in 3.1 and linear time vs strength data for similar grout mix.
3.3 Check grout pour continuity for the intruder grout with special consideration of dome grout.

3.4 Calculate compressive stress in the reducing grout at the flexible base slab at completion of grout pour.

3.4 Calculate compressive stress in the intruder grout for the maximum backfill load.

3.5 Calculate compressive stress in the flexible base slab for the grouted tank plus the maximum backfill load.

3.6 Use the following parameters in the calculations:

1. Grout unit weight = 128 lb/cu ft (pcf) \[1\]
2. Soil backfill unit weight = 125 pcf \[6, 7\]
3. Reducing grout strengths: \[3\] Table 4
   - 7 days = 360 psi
   - 28 days = 1085 psi
   - 56 days = 1300 psi
   Use linear variation as time between these control points.
4. Intruder grout strength: \[1\]
   - 28 days = 2000 psi
   Use linear variation from 0 to 2000 psi.
5. **Allowable soil bearing pressure under the flexible base slab = 3700 lb/sq ft (psf)**, [9]

6. **Allowable soil bearing pressure under the tank foundation annulus = 10000 psf**, [9]

7. **Flexible base slab nominal concrete strength of 3000 psi is multiplied by the factor of 0.7 due to historical thermal degradation**, [3]
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4.10 **Calculations**

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4.1 Grouting Sequence (Preliminary and Optional)

Grouting sequence and volume are summarized in Ref. 1 for closing Tank 18 and Tank 19 in F-Area. Continuous grouting could be employed in lieu of the sequence below.

Pour 1, 3, 5 — Reducing Grout, 128.17 pcf
Pour 2, 4, 6 — Dry Grout Mixture, 118.11 pcf
Pour 7, 9 — Reducing CLSM, 128.17 pcf
Pour 8, 10, 12, 14 — Dry Reducing CLSM, 118.04 pcf
Pour 11, 13 — Strong Grout, 125.08 pcf (Nutrobar Get)
Pour 15 — Riser Grout, 110.70 pcf (100 cy.)
4.2 **Flexible Slab Base Pressure**

The nominal grout volumes shown on the sketch above total 7342 cubic yards (cy) to the dome springline. The total grout volume under the dome to the springline, excluding the riser grout is 1190 cubic yards.

Ref. 1 requires the grout subcontractor to provide centralized batching facility capable of generating 75 cubic yards per hour. This rate of grout production is used to establish the fastest time each pour lift could be placed. The transition from pouring wet mix to placing dry mix would require changing equipment. Thus, twenty four hours time lapse is considered between wet mix pours. Lifts to base pressure = 3700 psf.

<table>
<thead>
<tr>
<th>Lift No.</th>
<th>Vol. (cy)</th>
<th>Time (hr)</th>
<th>(\frac{\text{Vol. (cy)}}{\text{Lift}})</th>
<th>(\sum\text{Depth (ft)})</th>
<th>Base Pres. (psf)</th>
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<tr>
<td>1</td>
<td>632</td>
<td>8.5</td>
<td>632</td>
<td>2.95</td>
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<td>2</td>
<td>30</td>
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<td>30</td>
<td>24</td>
<td>30</td>
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The base pressure is calculated using an average grout unit weight equal to 128 psf. Per drawing W167482 rev. 22, the allowable soil bearing pressure under the flexible base slab is 3700 psf. To preclude additional evaluation of the flexible base slab subjected to loads greater than the limiting value corresponding to the allowable soil pressure, the grout is considered fluid up to a depth, D, such that

\[ \gamma D + w_{(lab)} = 3700 \]

And allowed to cure until the grout block of depth D could be considered a rigid mass. Allowing for \( w_{(lab)} = 100 \) psf and \( \gamma = 128 \) psf:

\[ D = \frac{3700 - 100}{128} = 28.13 \text{ ft.} \]

The lift sequence shown on SHT. No. 12 would allow the grout to develop strength before D above is reached. Alternatively, the dry grout is optional and the pour rate would be continuous at 75 cu. yds. per hour.
4.3 Tank Wall

Find fluid grout depth \( D \) such that the resultant internal pressure is equal to the resultant external at-rest soil pressure. Consider soil unit weight \( w_s = 120 \)pcf and at-rest soil pressure coefficient \( k_0 = 0.5 \). Soil depth to the level of the tank bottom is 40.5 ft. (Ref. 5, Para. 69)

\[
2430 - 0.5 \times 120 \times D = 2430 - 60D
\]

\[
\frac{1}{2} \times 128D \times D = 64D^2
\]

\[
0.5 \times 120 \times 40.5 = 2430 \text{ psf}
\]

\[
(2430 - 30D) \times D = 64D^2
\]

\[
D = \frac{2430}{94} = 25.85 \text{ ft.}
\]
4.4 Grout Pour Continuity

Continuous Grout Pour at 75 cubic yards per hour.

The total depth of continuous grout pour, where the grout is considered fluid, is 25.85 ft. with no additional evaluation of tank integrity.

The time required to reach this depth, considering the rate of pour is 75 cubic yards per hour, is

\[ T = \frac{\pi \times (4.25)^2 \times 25.85}{27 \times 75} \]

\[ = 72 \text{ hrs.} \quad (3 \text{ days}) \]

At this point allow the poured grout block of depth \( D = 25.85 \text{ ft.} \) to develop strength \( f'_{c} \) and determine the average \( f'_{c} \) that would allow continuation of grout pour to the high point of the dome underrise. The maximum fluid grout depth for this condition would be

\[ D' = 34.28 + 10.63 - 25.85 \]

\[ = 19.06 \text{ ft.} \]
Calculation Continuation Sheet

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Sheet No. 16
Rev. 0

$D' = 19.06' \text{ (fluid)}$

$42.5 - \frac{D}{2} = 29.58'$

$D = 25.85' \text{ (rigid)}$

$42.5'$
For the condition shown on suit. No. 16 the poured grout block of depth D is fully supported by the flexible base slab and soil pressure less than 3700 p.s.f. After the poured grout block has gained strength the additional load of 128 x D' p.s.f would be transmitted to the flexible base slab through the rigid block of depth D. Consider that the block has sufficient strength if the punching shear stress does not exceed the average punching shear capacity.

With the punching shear load as shown on suit. No. 16 and using allowable stress design (Ref. 2, App.A)

Allowable shear \( V_c^L = (1 + \frac{2}{\beta_c}) f_c^c \leq 2 V_c^L \)

\[ = 2 \sqrt{f_c^c} \quad \beta_c = 1.0 \]

Demand shear \( V_c = \frac{\pi(29.58)^2 \times 128 \times 19.06}{2 \times 2 \times 29.58 \times 25.85 \times 144} = 9.69 \text{ psi} \)

\[ \therefore \text{ Ave. } f_c^c = \left( \frac{V_c}{2} \right)^2 = \left( \frac{9.69}{2} \right)^2 = 23.5 \text{ psi} \]
The chart above depicts the strength vs. time curve for the typical reducing grout mix (Ref. 3). Conservatively consider linear variation between control points and find the time $T_i$ for the first pour to achieve twice the required average grout strength of 23.5 psi. This would account for grout strength variation from 47 psi at bottom to zero at top.

$$T_i = 7 \times \frac{2 \times 23.5}{360} = 0.91 \text{ day (22 hrs)}$$

Since $T_i$ is less than $T = 72$ hrs needed to pour grout to depth $D = 25.85$ ft, the average strength of the poured grout would exceed $f'_c = 23.5$ psi and the poured grout of depth $D = 25.85$ ft could be considered as a rigid block. Grout pouring need not stop.
4.5 **Tank Dome Intruder Grout**

![Diagram of a tank dome with load W_D, height h = 10.63 ft, span L = 42.5 ft, radius R = 90.33 ft.]

**Consider intruder grout continuous pour retaining fluid from the springline to the highest point of the dome underside.**

- \( h = 10.63 \text{ ft} \)
- \( L = 42.5 \text{ ft} \)
- \( R = 90.33 \text{ ft} \)
- \( \gamma = 128 \text{pcf (fluid grout)} \)

The net uplift is equal to the displaced volume multiplied by \( \gamma \) minus dome dead load \( W_D \).

\[
U = \text{Uplift} = \left( \pi L^2 h - \frac{\pi}{3} h^2 (3R-h) \right) \times \gamma \quad \text{(Ref 4, Pg 18, 19)}
\]
\[ U = \pi h \tau \left( r^2 - hR + \frac{h^2}{3} \right) \]

\[ = \pi \times 10.63 \times 0.128 \times \left( \frac{42.5^2 - 10.63 \times 90.33 + \frac{10.68^2}{3}}{4} \right) \]

\[ = 3777.48 \text{ k} \]

\[ W_d = 3452.68 \text{ k} \quad \text{(Ref. 5 p. 519)} \]

**Net uplift** = \[ U - W_d \]

\[ = 324.80 \text{ k} + \text{ N.G.} \]

**Find net uplift if first two feet of intruder grout is allowed to harden.**

\[ h_1 = 10.63 - 2 = 8.63 \text{ f.} \]

\[ \tau_i = \left( R^2 - (R - h_1)^2 \right)^{1/2} = 38.53 \text{ f.} \]

\[ \tau_w = 62.4 \text{ pcf (water)} \]

\[ U = \pi h_\tau \delta \left( r^2 - hR + \frac{h^2}{3} \right) + \pi h_1 \left( \delta - \delta_w \right) \left( \tau_i - h_1 R + \frac{h_1^2}{3} \right) \]
\[ U_1 = 3777.48 \times \frac{62.4}{128} \]

\[ + \pi \times 8.63 \times (128-62.4) \times \left( \frac{8.63^3}{3} - 8.63 \times 90.33 + \frac{8.63^2}{3} \right) \times \frac{1}{1000} \]

\[ = 3139.57 \text{ k} < W_D = 3452.68 \text{ k} \text{ kN} \]

Pour intruder group to a depth of 2 ft, above the dome springline and allow to harden for 24 hrs. The remainder of the intruder group could be one continuous pour.

For dome pour \( D = 2 \text{ ft} \),

\[ V_2 = \frac{1}{27} \times \frac{\pi}{3} \left( \frac{R}{3} (3R-h) - h_1 \left( \frac{R}{3} - h_1 \right) \right) = 383 \text{ c.y.} \]

Pour 383 c.y.

Stop 24 hrs

Continue
4.6 Maximum Grout Stress / No Backfill

At the completion of tank grout pour to the high point of the dome underside the maximum compressive stress in the reducing grout at the flexible base slab is

\[
\sigma = (34.28 + 10.63) \times 128 \times \frac{1}{144} = 39.92 \text{ PSI}
\]

Consider allowable stress of \(0.8 f'_c\) (Ref. 2, APA)

\[
\sigma = 0.8 f'_c = 39.92 \text{ PSI}
\]

\[
f'_c = 133 \text{ PSI}
\]

From the linear graph on SHT. No. 18 the required \(f'_c\) is reached in

\[
T = 7 \times \frac{133}{360} \times 24 = 62 \text{ HRS.}
\]
To is less than the time required to fully grout the tank in one continuous pour except for the required 24 hrs break at the dome pour.

\[ T = \frac{7342 + 1190}{75} + 24 = 138 \text{ hrs.} \]

Thus, \( f'_c \) is greater than 133 psi.
4.7 **Backfill Over Grouted Tank**

The fully grouted tank is considered as one solid block and the in-place grouted tank dead load plus backfill material placed over it could be considered as uniformly distributed load over the tank foundation footprint which has a radius of 45.33 ft. \( A = \pi \times 45.33^2 = 6455.37 \text{ ft}^2 \)

4.7.1 **Tank Base Load / No Backfill**

Empty tank (Ref. 5, p. E39)

- **Foundation** = 241.28 k
- **Soil Annulus** = 312.19 k
- **Dome DL** = 3452.68 k
- **Wall Girder DL** = 1557.39 k
- **Flexible Slab** \( \frac{248 - \frac{7}{4} \times 40.5 \times 0.1}{8888.84} = 515.30 \) k

**Grout**:

- **Cylinder** = \( 7342 \times 27 \times 0.128 = 25373.95 \) k
- **Dome** = \( 1170 \times 27 \times 0.128 = 4112.04 \) k
- **Riser** = \( 100 \times 27 \times 0.128 = 345.60 \) k

\[ W_0 = 38721.03 \text{ k} \]
\[ q_0 = \frac{W_o}{A} \]

\[ = \frac{38721.03}{6455.37} = 6.00 \text{ ksf} \]

Reducing Grout: \[ \sigma = \frac{6000-100}{144} = 40.97 \text{ psi} \]

Flexible Base Slab: \[ \sigma = \frac{6000}{144} = 41.67 \text{ psi} \]

Intruder Grout: \[ \sigma = \frac{10.63 \times 128}{144} = 9.45 \text{ psi} \]
4.7.2 **Backfill Scenarios**

**EL. 228.64 (REF)**

**34.28**  
**SHT. NO. 11**

**242.92**  
**SHT. NO. 11 (DWG. W167471R21, SEC. A-A)**

**273.55**  
**(Dome Apex Underside)**

**276.80**  
**3.25**  
**1.00**  
**277.80**  
**Soil Cover at Dome Apex**  
**Estimated: From Soil Cover to Top of Plug**

**EL. 277.80 (Backfill 1) - 1 ft Above Soil Cover**

**10.00**

**EL. 287.80 (Backfill 2) - 11 ft Above Soil Cover**

**EL. 291.00 (Backfill 3) - 14.2 ft Above Soil Cover**

**EL. 294.50 (Top Evaporator Cover)**

**10.00**

**EL. 304.50 (Backfill 4) - 27.7 ft Above Soil Cover**
Calculation Continuation Sheet

Calculation No. T-CLC-F-00373

Sheet No. 27

Rev. D

CROSS-HATCHED AREA

\[ W_0 = 38721.03 \text{ k} \]

USE BACKFILL UNIT WEIGHT = 125 pcf. SEE REF. 6 AND 7 FOR GUIDANCE.

BACKFILL (1)

\[ W_1 = \left( \frac{\pi}{6} \times 45.33 \times 8.66 - \frac{\pi}{6} \times 7.66 \times (3 \times 93.58 - 7.66) \right) \times 0.125 \]

\[ = 4890.52 \text{ k} \]

\[ \sum W_1 = 38721.03 + 4890.52 = 43611.55 \text{ k} \]

\[ q_0 = \frac{43611.55}{6455.37} = 6.76 \text{ ksf} \]
4.7.4 **Backfill**

\[ W_2 = \pi \times 45.33 \times 10.0 \times 0.125 + 4890.52 \]

\[ = 12959.74 \text{ k} \]

\[ \sum \text{W}_2 = 38721.03 + 12959.74 = 51680.76 \text{ k} \]

\[ q_2 = \frac{51680.76}{6455.37} = 8.01 \text{ ksf} \]

4.7.5 **Backfill**

\[ W_3 = \pi \times 45.33 \times 3.20 \times 0.125 + 12959.74 \]

\[ = 15541.89 \text{ k} \]

\[ \sum \text{W}_3 = 38721.03 + 15541.89 = 54262.92 \text{ k} \]

\[ q_3 = \frac{54262.92}{6455.37} = 8.41 \text{ ksf} \]
4.7.6 **Backfill**

\[
W_0 = \pi \times 45.33 \times 13.50 \times 0.125 + 15541.89 \\
= 26435.33 \text{ kN}
\]

\[
\Sigma W = 38721.03 + 26435.33 = 65156.36 \text{ kN}
\]

\[
\frac{Q}{W} = \frac{65156.36}{6455.37} = 10.09 \text{ kSF}
\]

4.7.7 **Stresses - Reducing Group, Flexible Base Slab, Intruder Group**

1. **Reducing Group**

\[Q\] is the highest subgrade reaction considered.

The corresponding nominal stress in the reducing group at the top of the flexible base slab would be

\[\sigma = \frac{10090 - 100}{144} = 69.4 \text{ psi}\]

Using allowable stress design (Ref. 2, App. A):

\[\sigma = 0.3 f_c'\]

\[f_c' = \frac{69.4}{0.3} = 232 \text{ psi}\]

This is the required strength of the reducing group at the completion of backfill.
Use the linear plot of grout $f_c^1$ vs time (Ref. 3) shown on SHT. NO. 18. The set time needed to reach the required strength is $T = (232/360) \times 7 \times 24 = 108$ hrs or 30 hrs before completion of grout four operations, (SHT. NO. 23).

2. Flexible Base Slab

As noted on Drawing W167482, Rev. 22, the flexible base slab concrete design strength is $f_c^1 = 3000$ psi at 28 days. Considering thermal degradation factor $N^* = 0.7$ (Ref. 8, SHT. NO. 11)

$$f_c^{1*} = 0.7 \times 3000$$

$$= 2100 \text{ psi}$$

$$0.3 f_c^{1*} = 630 \text{ psi} > \frac{10090}{144} = 70.07 \text{ psi} \text{ OK}$$

3. Intruder Grout

Consider $W_0 = 26435.33$ k transferred directly on the dome intruder grout,

$$\sigma = \frac{26435.33}{42.5} \times \frac{1000}{144} + 9.45 = 41.80 \text{ psi}$$
WITH $\sigma = 0.3 \frac{1}{f_c}$, THE REQUIRED STRENGTH OF THE INTRUDER GROUT WHEN LOADED BY $W_2$ IS

$$f'_c = \frac{41.80}{0.3} = 140 \text{ PSI}$$

Ref. 1, pg. 8 gives for reference $f'_c = 2000 \text{ PSI}$ at 28 days. Considering linear strength gain from 0 to 2000 PSI in 28 days, $f'_c = 140 \text{ PSI}$ would be achieved in 2.6 days. Thus, at the completion of BACKFILL 4, the strength of the intruder grout would exceed 140 PSI.

4. The calculated stresses due to lower loads corresponding to backfill scenarios 1, 2, and 3 are tabulated below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Backfill 1</th>
<th>Backfill 2</th>
<th>Backfill 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Grout</td>
<td>46.25</td>
<td>54.92</td>
<td>57.71</td>
</tr>
<tr>
<td>Flexible Base Slab</td>
<td>46.94</td>
<td>55.43</td>
<td>58.40</td>
</tr>
<tr>
<td>Intruder Grout</td>
<td>15.44</td>
<td>25.31</td>
<td>28.47</td>
</tr>
</tbody>
</table>
5.0 Summary of Calculation Results and Conclusions

5.1 Grout unit weight average of 128 psf derived from data shown in Section 4.1 (Ref. 1) is used to calculate tank and foundation loads and grout stresses.

5.2 The maximum depth of fluid reducing grout without exceeding the allowable soil bearing pressure of 3700 psf under the flexible base slab is \( D = 28.13 \text{ ft} \) (Sht. No. 13).

5.3 The maximum depth of fluid reducing grout without exceeding the at-rest soil pressure against the tank wall is \( D = 25.85 \text{ ft} \) (Sht. No. 14). At a continuous pouring rate of 75 cu. yd. per hr, depth \( D = 25.85 \text{ ft} \) would be reached in 72 hrs (Sht. No. 15).

5.4 The time required to pour to depth \( D = 25.85 \text{ f} \) exceeds the time required for this block to gain strength to be considered rigid with respect to the flexible base slab (Sht. No. 18).
Therefore, continuous pouring of the reducing grout could continue uninterrupted beyond \( D = 25.85 \) ft. to the dome springline.

5.5 The intruder grout pour sequence from the dome springline to the dome apex must be interrupted at \( D = 2 \) ft., or roughly 383 cu. yd. poured, and allowed to cure for 24 hrs before resuming grout pour to completion. This would preclude the possibility of excessive dome uplift (Section 4.15).

5.6 At the completion of tank grouting or 138 hrs of continuous grout pour, the compressive stress in the reducing grout at flexible base slab interface is \( \sigma = 39.92 \) psi which requires nominal grout strength \( f'_{c} = 133 \) psi. This required \( f'_{c} \) is reached in 62 hrs., or less than the time that has already elapsed. (Section 4.6)
5.7 Before the grouted tank is buried in backfill, the presumptive uniform soil pressure at the base is 6.00 ksf. (SHT. NO. 25)

5.8 The following backfill scenarios and the corresponding presumptive uniform soil pressure at the tank base were considered in the calculations: (Section 4.7) (See also Section 2.6)

1. To dome apex riser —— $\phi_1 = 6.76$ ksf
2. To level of existing berm —— $\phi_2 = 8.01$ ksf
3. 10 ft. above dome apex riser —— $\phi_3 = 8.41$ ksf
4. 10 ft. above top of Evap. Blg. —— $\phi_4 = 10.09$ ksf

5.9 The following compressive stresses were calculated for the reducing grout, intruder grout and flexible base slab considering backfill scenario 4 above.

5.9.1 Reducing grout, $f_c = 69.4$ psi. The required reducing grout $f'c = 232$ psi is reached before the tank is fully grouted. (SHT NO. 29)
5.9.2 Intruder Grout, $\sigma = 41.80$ psi. The required Intruder Grout $f'_{c_1} = 140$ psi is reached 48 hrs. after grouting is completed. (SH. No. 30)

5.9.3 Flexible Base Slab, $\sigma = 70.07$ psi is less than $0.3 \times f'_{c_2} = 0.3 \times 2100 = 630$ psi. $f'_{c_2}$ is the thermally degraded flexible base slab concrete strength. (SH. No. 30)

5.10 The loaded tank footprint has a radius of 45.33 ft. Roughly 16 percent of the loaded footprint is the footing annulus with an allowable soil bearing pressure of 10,000 psf. The average soil bearing pressure is then

$$2_{ave} = 0.16 \times 10 + 0.84 \times 3.7$$

$$= 4.71 \text{ kSF \hspace{1cm} vs \hspace{1cm} } 2_{c} = 10.09 \text{ kSF}$$

The increase in soil bearing pressure has no structural significance with respect to the integrity of the fully grouted tank. SRS Geotechnical will evaluate the tank closure for ultimate settlement.
5.11 Grout and Concrete Compressive Strength and Stresses on the Closed Tank

The table below summarizes the grout and concrete compressive strength and stresses on the closed tank.

<table>
<thead>
<tr>
<th>Component (Grout or Concrete)</th>
<th>Stresses with No Cap (psi)</th>
<th>Stresses due to Cap 10 Feet Above the Tank Top (psi)</th>
<th>Stresses due to Cap at Existing West Grade (psi)</th>
<th>Stresses due to Cap 10 Feet Above the 242-F Evaporator (psi)</th>
<th>Design Compressive Strength @ 28 Days (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intruder Grout</td>
<td>10</td>
<td>26</td>
<td>29</td>
<td>42</td>
<td>2000 (1)</td>
</tr>
<tr>
<td>Reducing Grout</td>
<td>41</td>
<td>55</td>
<td>58</td>
<td>69</td>
<td>1085 (2)</td>
</tr>
<tr>
<td>Concrete Basement</td>
<td>42</td>
<td>56</td>
<td>59</td>
<td>70</td>
<td>3000 (3)</td>
</tr>
</tbody>
</table>

Notes:

(1) C-SPP-F-00047, page 44.
(2) WSRC-TR-98-00271, Table 4, page 17.
(3) W167432, Rev. 22.
6.0 REFERENCES

1. SPECIFICATION No. C-5PP-F-00047 REV. 2

2. ACI 318-95, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE, AMERICAN CONCRETE INSTITUTE, 1995.

3. WSRC-TR-98-00271 3/30/38

4. THE ENGINEERS' MANUAL, SECOND EDITION, RALPH G. HUDSON, JOHN WILEY & SONS, INC., 1939.

5. CALCULATION T-CLC-F-00791, REV. A

6. WSRC-TR-2002-00354

7. CALCULATION T-CLC-E-00018

8. CALCULATION T-CLC-G-00156, REV. 3

9. DRAWING W16-1482 REV. 22
May 15, 2006

TO: W. E. Faires, Jr.  
Structural Mechanics, 730-1B

FROM: B. A. Martin  
PIT Tank Closure Planning, 766-H

Tank 18 and 19 Closure Structural Calculation

Background

Tank closure plans include the use of two kinds of grout for closure of Tank 19 and Tank 18. Reducing grout will be used to fill the tank from the bottom to approximately the beginning of the dome (springline) to provide a long term chemical environment to reduce leaching of radionuclides into the environment and to provide compressive strength. Intruder grout will be used to fill the tank from the springline up to the tank top to provide compressive strength and to deter intrusion (Reference 1).

Task

Calculate the forces imposed on the three components of the closed tanks: 1) intruder grout, 2) reducing grout, and 3) concrete basemat from the overlying materials. Compare these forces to the compressive strength design values of these three components. The compressive strength design values for the intruder grout and reducing grout is given below. The compressive strength design value for the basemat must be determined. The calculation of forces shall include the following scenarios for an engineered cap: 1) no cap, 2) a cap 10-feet above the center riser, 3) a cap up to the existing grace around the 17-20 area, and 4) a cap 10-feet above the top of the 242-F evaporator.

Inputs

2) The design mix formula for reducing grout is Reducing grout, Mix No. OPD2EXE-X-F-0-BS, Reference 2, page 46.
3) The compressive strength design value for intruder grout is 2000 psi (Reference 2).
4) The compressive strength design value for reducing grout is 1085 psi (Reference 3).
5) The configuration of the intruder grout and reducing grout is described in Reference 1.
6) The engineered cap wet bulk density value is 125 pounds per cubic foot based on Reference 4, sheet 36.
cc: T. C. Robinson, Jr., 766-H

References: