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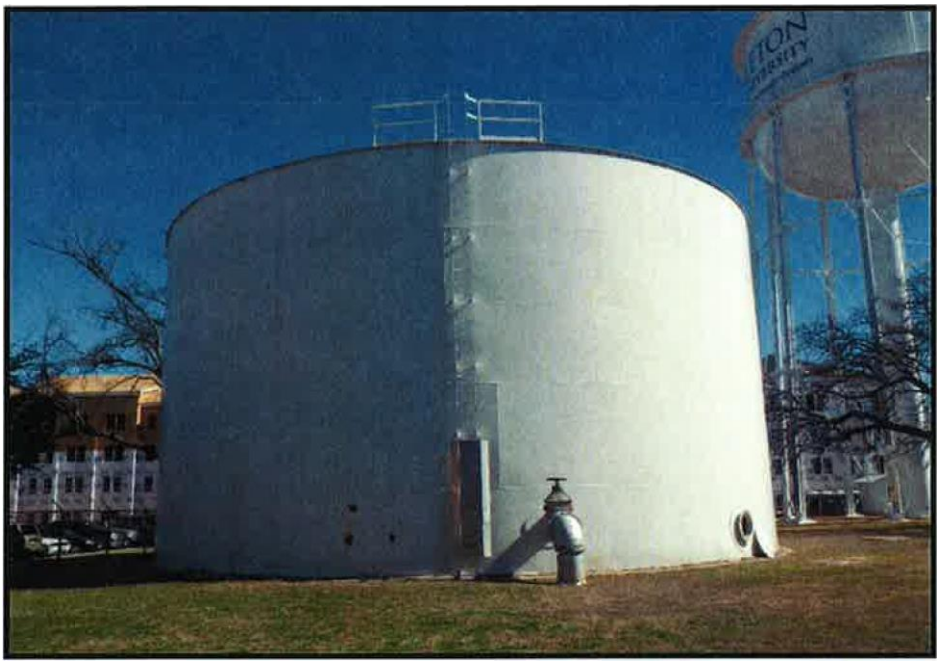

EVALUATION OF THE

750,000 GALLON STEEL GROUND STORAGE TANK

"GARFIELD TANK"
STEPHENVILLE, TEXAS

FOR

CITY OF STEPHENVILLE
STEPHENVILLE, TEXAS

February 9, 2015

14.237.S1508.002

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SUBJECT:

The subject of this report is the field evaluation of the 750,000 gallon steel ground storage tank in Stephenville, Texas. The tank was owned by the City of Stephenville and was known as the "Garfield Tank." The field evaluation was performed on February 9, 2015 by James A. Peyer and Jesse A. Jenkins of Tank Industry Consultants. The Owner's representative on the site at the time of the field evaluation was Dennis Connelly. The conical column and rafter supported roof tank was of welded steel construction. , According to information supplied by the owner, the tank was constructed in 1960. Measurements taken during the evaluation indicated that the tank height was approximately 32 ft 6 in. and the tank diameter was approximately 63 ft 10 in.

OBJECTIVE:

The purpose of this evaluation was to determine the condition of the tank interior, exterior, exposed foundation, and accessories. The purpose of this report is to present the findings of the evaluation and to make recommendations for recoating, repairing, corrosion protection, and maintenance. Budget estimates for the work, anticipated life of the coating and the structure, and the replacement cost of the tank are also included.

AUTHORIZATION:

This evaluation and report were authorized in the TIC Standard Agreement dated November 6, 2014 signed by Nick Williams.

EXECUTIVE SUMMARY:

Areas of top coating on the exterior had peeled to the underlying coating. Tank Industry Consultants recommends that the exterior be recoated in the next 3 to 5 years. Coating failures were widespread over the interior surfaces. Large areas of the interior coating had peeled to the underlying coating. Heavy corrosion and metal loss were observed on the interior surfaces. Tank Industry Consultants recommends that the interior surfaces be recoated in the next 1 to 2 years. Proper maintenance after completing the recommendations herein would include periodic washouts and evaluations approximately every 3 to 5 years in accordance with AWWA recommendations.

ANSI/OSHA and Safety-Related Deficiencies: There were OSHA and safety-related deficiencies on this tank. These deficiencies included:

- the valve vault electrical receptacles were not equipped with ground fault interrupt circuits
- standing water was observed in the valve vault with electrical receptacles present,
- the exterior shell ladder was not equipped with a safe-climbing device (29 CFR 1926.1053(a)(l9)),
- the exterior shell ladder side rails were too small (ANSI A14.3),
- the exterior shell ladder vandal deterrent was not equipped with side panels,
- the gap between the safety railing toe bar and the roof was too large (29 CFR 1910.23(e)(4)),
- the safety railing access opening was not equipped with closure chains (29 CFR 1910.23(a)(2)),
- the roof was equipped with only one manhole (AWWA),
- the interior container ladder was not equipped with a safe-climbing device (29 CFR 1926.1053(a)(19)),
- the interior container ladder side rails were too small (ANSI A14.3), and
- the interior container ladder should not be used due to the corrosion and metal loss present.

If the Owner wishes to fully comply with OSHA and safety-related standards, it is recommended that these deficiencies be rectified.

AWWA, TCEQ, and Operational Deficiencies: There were sanitary and operating deficiencies on this tank as well. These deficiencies included:

- the tank was not equipped with a water level indicating device,
- ponding was observed on the roof near the roof perimeter,
- the roof vent was not of a clog-resistant design,
- the rafters and the center hub below the roof vent may restrict airflow and not allow the roof vent to operate properly,
- the protective screening on the roof vent was not shielded from wind-driven rain or debris, and
- the interior overflow pipe is susceptible to accelerated corrosion.

These deficiencies should be corrected.

The safety-related, sanitary, and operating deficiencies listed above are not intended to be a complete list of deficiencies on this tank. The Owner should refer to the complete report text and accompanying photographs for a complete account of all observed deficiencies.

This evaluation and the reporting of the condition of this tank do not warrant the original structural condition of the tank or any of the original design for seismic loadings. Likewise, recommendations for this tank do not include modifications which may be required for compliance with present structural codes.

PHOTOGRAPHS:

Color photographs were taken of the visible portions of the foundation, the tank interior and exterior and are included as a part of this report. The significant photographs are keyed to the observations.

NOMENCLATURE:

The terms used in describing the various components of steel water tanks are unique to the industry. In fact, the terms vary from firm to firm and from person to person. In an attempt to define the terms used in this report, a sketch of the general type of tank covered is included at the end of the narrative portion of this report. Each horizontal row of steel plates on the tank is referred to as a "shell ring" or "ring." To aid in referencing the shell rings, the bottom ring is referred to as shell ring 1 and the top ring is shell ring 5. **Warning: Some appurtenances on this tank may be referred to as erection or rigging attachments, lugs, or brackets. This does not mean that they are safe for rigging. Each attachment for each tank should be evaluated on an individual basis by a structural engineer or an experienced rigger before being used. These devices may have been intended for only the original erectors and painters to use with specialized equipment.**

ADHESION TESTS:

All adhesion tests performed during this evaluation were done in general accordance with ASTM D3359. The results are reported herein using the ASTM scale. The ASTM scale is a relative scale to rate adhesion from O to 5 with 5 being the best. A table of adhesion test results classification is included with this report following the sketch of the tank.

HEAVY METALS TESTS:

Samples of the exterior and interior coating systems were sent to a laboratory for inductively coupled plasma-atomic emission spectrometry analyses. The test results were as follows:

	Cadmium		Chromium		Lead	
	mg/kg	percent	mg/kg	percent	mg/kg	percent
Exterior	<25	<0.0025%	1570	0.157%	69,000	6.9%
Interior	<25	<0.0025%	<250	<0.025%	<250	<0.025%

Tank Industry Consultants performs this test only to determine if there is lead, cadmium, or chromium present in the coating samples. To limit damage to the existing coating, only small areas were tested. The small number of samples taken and the difficulty of retrieving all primer from the steel profile may cause the tests performed to not accurately represent the total coating system. Variations in thickness, types of coatings applied, and the interim cleaning and painting operations will also affect the actual readings. The reliability of the results is also dependent on the amount of primer included in the sample. The Consumer Product Safety Commission specifies that an amount greater than 0.06% lead is considered potentially hazardous. Additional testing to determine the amount of leachable contaminants present in the spent cleaning debris will need to be performed following cleaning operations at the time of repainting. Results from the laboratory analysis are included following the adhesion tables.

ULTRASONIC TIDCKNESS l\1EASURE1\1ENTS:

	(all readings were taken through coating)
Roof Plates:	0.220 in. to 0.223 in.
Shell:	
Ring #5:	0.300 in. to 0.303 in.
Ring #4:	0.280 in. to 0.285 in.
Ring #3:	0.284 in. to 0.290 in.
Ring #2:	0.384 in. to 0.386 in.
Ring #l:	0.482 in. to 0.485 in., bottom
Bottom Plate:	0.248 in. to 0.255 in.

OBSERVATIONS:

A. Foundation and Site

SITE:

Size: approx. 190 ft x 230 ft

Fence:

Type: chain link, with 3 strands of barbed wire

Height: 6 ft

Gates:

Number: 4

Locations: south and east sides of site

Widths: 16 ft and 4 ft on south side and 12 ft and 3 ft on east side

Locked: yes

Nearest Structures:

Type: building
Direction: east
Distance: approx. 29 ft

Type: building
Direction: southwest·
Distance: approx. 47 ft

Type: elevated water tank
Direction: southeast
Distance: approx. 60 ft

Nearest Overhead Power Lines:

Direction: south
Distance: approx. 138 ft

FOUNDATION:
Type: concrete ringwall
Projection Above Grade:
North: 1 in. to 6 in.
South: 0 in. to 3 in.
East: 2-1/2 in. to 7 in.
West: 0 in. to 2 in.
Grout: none
Sealant: none
Fiberboard: none

VALVE VAULT:
Location: approx. 13 ft south of tank
Size: 4 ft x 8 ft x 4 ft 6 in. deep
Access:
Size: 33 in. square
Locked: no
Ladder: none

1. **Site Location:** The tank was located up a 12 ft wide concrete drive at 800 North Garfield Avenue in Stephenville, Texas. The site was located in a residential area as the site was adjacent to apartments on a college campus. Overhead power lines were located to the south of the site along the adjacent street. The main access to the site was through a gate on the south side of the site. (See photos 1-4)

2. **Site Conditions:** The tank site was covered with grass. The site appeared flat and may not provide adequate drainage away from the foundation; however, no standing water was observed near the tank during the evaluation. The tank site was fenced. The chain link fence was topped with barbed wire and was equipped with four gates. Two of the gates were on the south side of the site and the other two gates were located on the east side of the site. The fence appeared to be in good overall condition and appeared to satisfy TCEQ requirements. A "No Trespassing" sign was located on the fence adjacent to the main gate. An elevated water storage tank was located on the site to the south east of the tank. Two brick buildings were on the site with one to the south of the tank and the other to the east of the tank. A tree was overhanging the roof on the north side of the tank. (See photos 1-4)

3. **Foundation:** The tank foundation appeared to be a concrete ringwall. The majority of the foundation was not visible at the time of the field evaluation. The foundation did not exhibit the AWWA recommended 6 in. to 12 in. projection above grade. The visible portion of the foundation appeared to be in good overall condition; however, cracking was observed in areas where the foundation had been repaired. A concrete skirt surrounded the foundation. Vegetation had grown between the foundation and the concrete skirt. No coating was visible on the exposed concrete surfaces at the time of this field evaluation except for overspray from the tank coating. No grout or sealant was visible at the foundation to bottom plate interface. (See photos 10-15)

4. **Valve Vault: There were safety and OSHA deficiencies noted:** (1) **the electrical receptacles** in **the valve vault were not equipped with ground fault interrupt circuits, and (2) the valve vault was equipped with electrical receptacles and there was standing water** in **the bottom of the vault.** There was a valve vault located on the east side of the tank site. Access into the valve

vault was not locked prior to or after this field evaluation. Heavy corrosion was observed on the valve vault access cover. The piping in the valve vault was generally rust covered and appeared to be in poor condition. Standing water was observed in the bottom of the valve vault. (See photos 5-9)

B. Exterior Surfaces

DESCRIPTION:
- Construction: welded steel
- Diameter: approx. 63 ft 10 in.
- Shell Height: approx. 32 ft 6 in.
- Shell Rings: 5
- Roof Type: column and rafter supported

NAMEPLATE: none

ANCHOR BOLTS: none

BOTTOM PLATE PROJECTION: 5/8 in. to 2 in. from shell

.SHELL MANHOLES:
- Number: 2
- Location: southwest side of shell ring #1
  - Type: flanged and bolted
  - Size: 24 in. diameter
  - Neck: 6 in. projection from shell x 7/16 in. thick
  - Flange: 4 in. wide x 1/2 in. thick
  - Bolts:
    - Number: 28
    - Size: 7/8 in. diameter x 2-1/2 in. long
  - Cover Plate:
    - Size: 32 in. diameter x 1/2 in. thick
    - Hinged: no

- Location: northeast side of shell ring #1
  - Type: flanged and bolted
  - Size: 30 in. diameter
  - Neck: 7-7/8 in. to 8-5/8 in. projection from shell x 1/2 in. thick
  - Flange: 4 in. wide x 1/2 in. thick
  - Bolts:
    - Number: 28
    - Size: 3/4 in. diameter x 3 in. long
  - Cover Plate:
    - Size: 38 in. diameter x 1/2 in. thick
    - Hinged: no

OVERFLOW PIPE:
- Size: 8 in. diameter
- Visible Air Break: 17-1/2 in.
- Protective Screen: none
- Flap Gate: yes
- Splash Pad: 47 in. wide x 116 in.

SHELL LADDER:
- Number of Rungs: 33
- Distance From Foundation to Lowest Rung: 15 in.
- Width: 16 in.
- Side Rails: 2 in. x 1/4 in., flat bar
- Rung Size: 3/4 in. diameter
- Spacing: 12 in. on center
- Toe Room: 8-1/2 in.
- Brackets:
  - Construction: welded
  - Size: 3 in. x 1/2 in., flat bar x 8 in. to 9-1/2 in. long
  - Spacing: approx. 56 in.
- Safe-Climbing Device: none
- Safety Cage: none
- Vandal Deterrent:
  - Type: aluminum ladder gate
  - Size: 32 in. wide x 8 ft high
  - Side Bars: none
  - Locked: yes

ROOF SAFETY RAILING:
- Handrail:
  - Height: 42 in.
  - Size: 1-7/8 in. diameter
- Uprights: 1-7/8 in. diameter
- Mid-Rail: 1-7/8 in. diameter
- Toe Bar:
  - Size: 4 in. x 3/16 in., flat bar
  - Height Above Roof: 5-3/4 in.
- Access Opening:
  - Width: 39 in.
  - Closure Chains: no

ROOF OPENINGS:

Manhole:

Size: 28-1/2 in. x 29-1/4 in.
Type: hinged
Curb: 4-1/4 in. x 4-3/4 in. x 1/4 in.
Welded: exterior only
Overlap: 2 in.
Locked: yes

Roof Vent:

Type: dome cover
Neck Height: 21 in.
Neck Diameter: approx. 30-3/4 in.
Screen:
Orientation: vertical
Size: 16 x 16 mesh

EXTERIOR COATING AND METAL CONDITION:

	Coating Thickness		Approx. % Failure to		Adhesion	Metal Loss	
	Range	Typical	Underlying Coating	Rust		Typical	Deepest
Shell	8.8 mils to 16.l mils	10.5 mils	< 1/2%	Neg.	OT	Neg.	Neg.
Roof	7 mils to 18 mils	11.5 mils	Neg.	Neg.	OT	Neg.	Neg.

Key to Table

Adhesion 5 (very good)
4 (good)
3 (fair)
2 (poor)
1 (very poor)
0 (very poor)

T =Topcoat to Underlying Coating

S = Primer to Steel

Neg.= negligible

1. **Exterior Coating Condition:** The coating on the exterior of the tank appeared to be in good to fair overall condition and was providing adequate protection from corrosion to most of the underlying steel. The exterior coating exhibited very poor adhesion to the underlying coating. Areas of the shell and roof coating had peeled to the primer. Random areas of corrosion were noted.

2. **Bottom Plate:** The tank bottom plate extension appeared to be in adequate condition; however, the perimeter edge appeared to have been torch cut and had rusted. Areas of the coating on the bottom plate had peeled to primer and rust. Large amounts of grass clippings were observed on the bottom plate. (See photos 10-15)

3. **Shell Condition:** The contour of the tank shell was good with no significant discontinuities observed at the time of this field evaluation. The coating appeared to be in good to fair overall condition and exhibited very poor adhesion to the underlying coating. The coating on the tank had chalked. Areas of the shell appeared to have touched up with caulking. The coating on the shell had peeled to corrosion and the underlying coating in areas. Large vertical streaks were observed in the

coating. A welded steel door sheet was observed on the south side of near the bottom of the shell on the south side. The door sheet consisted of a large rectangular cut out which had radiused comers and contained a large 5 ft diameter circular cut out in the center. A pipe exited the shell on the west side of the tank. The pipe appeared to be an outlet pipe and was equipped with a manually operated valve. The pipe was insulated and in a jacket. The insulation and jacket were bent and displaced in random areas. Minor corrosion was observed on the flange on the outlet pipe. A top shell angle was located at the top of the shell. Mildew was observed on the angle, and rust had streaked down the shell. (See photos 19-20, 25-32)

4. **Water Level Indicating Device: There was a TCEQ deficiency noted: a water level indicating device was not found at the site during the field evaluation.**

5. **Shell Manholes:** The tank was equipped with two flanged and bolted circular manholes. One of the manholes was located on the southwest side of the tank, and the other manhole was located on the northeast side of the tank. The shell plate around each of the manholes was equipped with a circular reinforcing plate. Coating had peeled off of the manhole flanges in areas, and metal loss was observed on the flanges. The manhole covers were not equipped with hinged supports. "Confined Space" warning signs were located on both of the shell manhole covers. One of the signs had begun to peel off. (See photos 21-24)

6. **Overflow Pipe:** The overflow pipe exited the shell near the base of the tank. The discharge end of the overflow pipe was equipped with a flap gate. The flap gate was not equipped with. a screen but appeared to adequately seal with no gaps noted. The overflow pipe discharged above a concrete splash pad which extended under the site fencing. The overflow pipe appeared to be in good overall condition with no significant corrosion noted. The penetration through the shell was equipped with a reinforcing pad. The coating on the reinforcing pad had peeled to the underlying coating in areas. (See photos 16-18)

7. **Exterior Shell Ladder: There were safety, ANSI; and OSHA deficiencies noted: (1) the ladder was not equipped with a safe-climbing device, (2) the 2 in. x 1/4 in. side rails did not meet the required 2-1/2 in. x 3/8 in. minimum, and (3) the vandal deterrent was not equipped with side panels to prevent unauthorized access up the back of the ladder.** The tank was equipped with a ladder which extended up from near .grade to the top of the shell at an opening the roof safety railing. The ladder was not equipped with a safe-climbing device. The exterior ladder was welded to brackets which were welded to the shell. The exterior ladder and brackets appeared to be in nearly their original structural condition at the time of this field evaluation. The ladder was equipped with a locked vandal deterrent at the base of the ladder; however, the vandal deterrent was not equipped with side plates. (See photos 33-37)

8. **Roof Safety Railing: There were safety-related and OSHA deficiencies noted: (1) the 1-3/4 in. gap between the toe bar and the roof exceeded the maximum allowable gap of 1/4 in., and (2) the roof safety railing access opening was not equipped with closure chains.** The roof was equipped with safety railing at the roof access. The safety railing was constructed of welded steel flat bar and pipe members. The access opening at the ladder was not equipped with removable closure chains. Large areas of pin head rust were observed on the roof safety railing. (See photos 32- 33, 36, 38-39)

9. **Roof Condition: There was a TCEQ deficiency noted: ponding was observed on the roof near the roof perimeter.** The contour of the roof was irregular as minor ponding was observed in approximately twelve locations near the perimeter edge of the roof. The coating on the roof appeared to be in fair overall condition and exhibited very poor adhesion to the underlying coating. The topcoating had peeled to the underlying coating in areas. Minor corrosion was observed on the roof Large amounts of weld spatter were observed on the roof. (See photos 40-44)

10. **Roof Manhole: There was a safety deficiency noted: the roof was equipped with only one manhole.** The roof was equipped with one manhole. The manhole was equipped with a hinged and locked cover. Heavy corrosion was noted on the manhole and cover interior. The roof manhole was locked prior to and after this evaluation. The roof manhole was welded on the exterior only. (See photos 38, 45-46)

11. **Roof Vent: There were TCEQ, sanitary, and operational deficiency noted: (1) the roof vent was not of a clog-resistant design, (2) the location of the vent due to the roof rafters and the center hub plating on the interior of the tank, may restrict airflow and not allow the vent to operate properly, and (3) the protective screening on the roof vent was not shielded from wind driven precipitation and debris.** The roof was equipped with a vent in the approximate center of the roof. The vent was bolted to a flanged opening the roof. The vent did not appear to be of a clog- resistant design. Corrosion was observed on the vent neck and cover. Nwnerous open bolt holes were observed on the flange. (See photos 47-48)

C. Interior Surfaces

ROOF SUPPORT SYSTEM:
- Main Rafters:
  - Number: 32
  - Size: 8 in. x 2-1/4 in., channel
- Attachment Clips:
  - Size: 3-1/2 in. x 3/8 in., flat bar x 5-1/2 in. long
  - Bolts:
    - Number: 2 per clip
    - Size: 5/8 in. diameter x 2 in. long
- Purlins: 2 in. x 2 in., angle
- Center Hub: approx. 42 in. diameter x 1/2 in. thick
- Center Column:
  - Type: 8 in. diameter pipe
  - Base Supports: 36 in. diameter over 5 ft x 70 in., plates

TOP SHELL ANGLE:
- Size: 3 in. x 3 in. x 1/4 in.
- Orientation: leg out

INTERIOR CONTAINER LADDER:
- Number of Rungs: 32
- Width: 16 in.
- Rung Size: 3/4 in. diameter
- Spacing: 12 in. on center
- Side Rails: 2 in. x 1/4 in., flat bar
- Toe Room: 7-1/2 in.
- Head Clearance: 27 in.
- Brackets:
  - Construction: welded
  - Size: 2 in. x 1/4 in., flat b x 8 in. long
  - Spacing: approx. 6 ft 9 in.
- Safe-Climbing Device: none

CATHODIC PROTECTION: none

OVERFLOW:
- Inlet Type: rectangular funnel
- Location: approx. 6 in. below the roof-to-shell connection
- Brackets:
  - Size: 2 in. x 3/8 in., CT-brackets
  - Spacing: approx. 5 ft 2 in.

INTERIOR PIPING:
- Inlet Pipe:
  - Size: 10 in. diameter
  - Projection: approx. 20 ft above floor
  - Brackets:
    - Size: 4 in. x 3/8 in., flat bar x 32-1/2 in. long
    - Spacing: approx. 5 ft

- Outlet Pipes:
  - Number: 1
  - Location: west side of tank
  - Size: 16 in. diameter pipe
  - Height Above Floor: 14 in.
  - Anti-Vortex Assembly: yes

  - Number: 2
  - Locations: southeast and east sides of tank
  - Type: bell type
  - Size: 12 in. diameter
  - Projection: 16 in. and 15 in.
  - Shrouds: 36 in. diameter
  - Brackets:
    - Number: 8 per pipe
    - Size: 3 in. x 3/8 in., flat bar x 15-3/4 in. long

Drain Pipe:
Size: 6 in. diameter
Projection: flush with bottom plate

INTERIOR COATING AND METAL CONDITION:

	Coating Thickness		Aoorox. % Failure to		Adhesion	Metal Loss	
	Range	Typical	Primer	Rust		Typical	Deeoest
Roof	10.8 mils to 18 mils	11.5 mils	Neg.	1/2%	4T	Neg.	Neg.
Shell	8.5 mils to 20 mils	12.5 mils	Neg.	*5%*	4Tand5S	Neg.	Neg.
Floor	6.3 mils to 12 mils	8 mils	Neg_	*5%*	OS	< 1/32 in.	1/32 in.

Key to Table

Adhesion
5 (vexy good)
4 (good)
3 (fair)
2 (poor)
1 (very poor)
0 (vexy poor)

T = Topcoat to Underlying Coating

S = Primer to Steel

Neg. = negligible

1. **Interior Coating Condition:** The coating on the interior surfaces of the tank appeared to be in poor overall condition. Corrosion, blistering, and pitting were observed on the interior surfaces. The coating exhibited very poor to very good adhesion to the underlying coating and steel.

2. **Roof Condition:** The coating on the roof plates and roof support structure appeared to be in poor overall condition as corrosion and metal loss were observed on the roof plates and the roof support structure. The roof support structure consisted of rafters, purlins, a center hub, and a center column. The roof rafters extended outward from the center hub and the outer ends were bolted to the shell. The purlins extended between adjacent roof rafters approximately halfway between the center hub and the shell. The column was welded to a plate attached to the center hub and extended down the floor. . The base support of the column consisted of four triangular plates which were welded to the column and to the circular reinforcing plate on the floor. The reinforcing plate was welded to a second reinforcing plate. Corrosion and minor metal loss was observed on the support structure; however, the heavier corrosion was near the center hub. Rust staining had streaked down the shell below the roof rafter ends in areas. (See photos 49-56, 60)

3. **Shell Condition:** The coating on the shell interior appeared to be in poor overall condition and had very good to good adhesion to the underlying coating and steel. Large quantities of what appeared to be abrasive were observed in the coating. Areas of corrosion were observed on the interior shell; however, the corrosion appeared to be isolated to the upper two shell rings. The shell coating was discolored due to mineral staining from the water. A top shell angle was located around the roof- to shell connection. Scale corrosion was observed at the top shell angle-to-shell connection. Bum marks were observed in the shell coating and appeared to have been caused by the installation of the ladder on the exterior of the tank. (See photos 57-58)

4. **Interior Container Ladder: There were safety and OSHA deficiencies noted: (1) the ladder was not equipped with a safe-climbing device, (2) the 2 in. x 1/4 in. side rails did not meet the required 2-1/2 in. x 3/8 in. minimum, and (3) due to the corrosion present, the ladder should not be used by personnel** The tank was equipped with an interior container ladder which extended

down from the roof manhole to the floor. The interior container ladder was welded to brackets which were welded to the shell. Corrosion was observed on the ladder rungs and brackets, with several of the rungs appearing to have significant metal loss. It **is the opinion of Tank Industry Consultants that the interior container ladder should not be used for personnel access.** (See photos 69-70)

5. **Overflow Pipe: There was an operational deficiency noted: the interior overflow pipe is susceptible to accelerated rates of corrosion.** The overflow pipe was equipped with a square funnel type inlet. The location of the overflow inlet was such that the top capacity level was below the shell-to-roof connection. The overflow pipe extended down the interior of the shell and exited the tank near the base. The overflow pipe was welded to brackets which were welded to the shell. The brackets appeared to be in adequate condition. (See photos 61-64)

6. **Bottom Plate Condition:** The coating on the tank bottom appeared to be in poor overall condition. The bottom plate coating adhesion was very poor as the coating had peeled in sheets in areas. Pitting and blistering were widespread over the bottom plate. The blisters were located in clusters and the majority were pinhead sized or smaller. Metal loss measurements taken during the evaluation indicated that the majority of the pits measured less than 1/32 in. in depth. The deepest pits measured approximately 1/32 in. deep. (See photos 71-75)

7. **Interior Piping:** The tank was equipped with one inlet pipe and three outlet pipes. The inlet pipe extended up the shell approximately 20 ft. The inlet pipe was welded to brackets which were welded to the shell. The brackets and pipe appeared to be in adequate condition. One of the outlet pipes was located on the west side of the tank. The outlet pipe extended out from the shell and bowed down towards the bottom plate. The opening was located 14 in. above the floor and was equipped with an anti-vortex assembly. The outlet pipe was equipped with a manually operated valve on the exterior of the tank. Two additional outlet pipes were located on the east and southeast sides of the floor. The outlet pipe appeared to be bell type and were equipped with shrouds. The shrouds were welded to the floor with eight brackets and were equipped with welded bars over the top. Minor corrosion was noted on the pipes, shrouds, and anti-vortex assemblies. (See photos 65-68, 76-80)

RECOM1\1ENDATIONS:

A. Foundation and Site

1. **Site Maintenance:** The site should .be regraded so that the top of the foundation projects a minimum of 6 in. to a maximum of 12 in. above grade and so that proper drainage away from the foundation occurs. Site maintenance should be performed with the mower discharge directed away from the base of the tank to prevent rock chips in the coating and the accumulation of grass on the bottom plate. The gate should continue to be locked at all times to deter unauthorized entry and limit liability for the Owner. Vegetation on the bottom plate and on or near the shell should be removed and should not be allowed to encroach on the foundation or steel in the future. This includes the tree overhanging the tank and the vegetation between the foundation and the skirt.

2. **Tank and Site Security:** Water tanks have been defined by some courts under certain circumstances as attractive nuisances. As such, there may be a significant potential liability to the Owner for injury to persons on the tank and tank site, even if access is not authorized. Recent events have prompted the entire water industry to consider measures that inhibit intentional acts that could

threaten the water supply. A review of the security requirements for the tank and site is recommended to confirm that the existing measures are consistent with the Owner's security requirements for their water system. Primary tank and site security should be focused on eliminating, preventing, and detecting unauthorized access to the tank. Such security measures might include routinely and periodically verifying all manholes and gates are locked, and all exterior ladders have suitable deterrents. Other security measures might include installing new site lighting, adding motion detectors on the site, installing surveillance cameras, installing alarms on gates and tank manholes, and arranging more frequent site visits by law enforcement agencies.

3. **Foundation:** When the tank exterior is repainted, any unsound concrete should be chipped to sound material and the concrete should be brush-off blasted. Any deteriorated areas or voids found should have a bonding agent and a vinyl emollient modified concrete patching mortar applied to build up the surface to its original contour. The concrete should then be painted with a concrete sealer.

4. **Outlet Pipe:** Toe insulation and jacket on the outlet pipe should be replaced.

5. **Valve Vault:** The piping and valves located in the valve vault should be cleaned and painted in accordance with the interior coating recommendations at the time of the tank cleaning and coating. The exterior concrete surfaces should be cleaned to the equivalent of a brush-off blast cleaning and painted with a concrete sealer. The valve vault access should be locked at all times in order to limit liability to the Owner and to protect water system security. Freeze protection should be provided for on all control piping and static water lines. The electrical receptacles in the valve vault should be equipped with ground fault interrupt circuits. A new sump with a pump should be installed in the bottom of the valve vault to prevent the accumulation of water in the valve vault.

B. Exterior Surfaces

I. **Life of the Exterior Coating:** The exterior coating system appeared to be providing adequate protection to the majority of the steel surfaces; however, areas of the coating had peeled to the underlying coating. Minor areas of corrosion were also observed on the shell and roof. Tank Industry Consultants believes that the exterior of the tank should be painted within the next 3 to 5 years. Due to the very poor adhesion of the existing exterior coating, topcoating is not recommended.

2. **Coating Testing:** Prior to preparation of specifications for the cleaning and coating of the exterior of the tank, samples of the exterior coating system should be subjected to laboratory analysis to test for ingredients which may at that time be subject to regulations concerning their handling and disposal.

3. **Cleaning:** Due to the fact that the present exterior coatings appear to contain lead and chromium, coating removal should be performed in accordance with local, state, and federal regulations relative to the removal of heavy-metal based coatings. When the exterior is to be cleaned, all varieties of containment should be investigated. Containment of the wind-blown debris and paint droplets will be required due to the proximity of the adjacent housing.

4. Recommended Coating System:

a. **Complete Cleaning and Repainting:** The optimum long-life coating system presently available for this site is an epoxy-polyurethane coating system. Properly formulated and applied, polyurethanes have good resistance to condensation, mildew, and chipping. The polyurethanes also have excellent color and gloss retention and the longest expected service life of any of the common exterior tank coatings. The typical life of a properly applied epoxy-polyurethane coating system is approximately 15 to 20 years. These coatings are also presently manufactured to meet current VOC requirements.

b. **Coating Application:** The entire tank exterior should be cleaned to the equivalent of an SSPC-SP 6, Commercial Blast Cleaning and have an epoxy-primed, epoxy intermediate and polyurethane finish coating system applied. However, care must be taken during the application of this particular coating system because this coating does have poor dry-fall characteristics, and potential damage to the surrounding property must be taken into consideration. The polyurethane coatings also require close monitoring of temperature and humidity during application.

5. **Effective Service Life:** Tank Industry Consultants defines the life of a coating as the amount of time before repainting becomes necessary due to coating failure and corrosion. During th.e coating life the Owner should expect the coating to lose its gloss, start to· chalk, show signs of weathering, and possibly some rust staining. Future touch-up may be required on isolated coating failures. If aesthetics are a concern, the Owner may have to topcoat the repainted tank prior to the end of the expected service life. However, future topcoating would be less expensive than complete cleaning and recoating and could delay the next complete cleaning and repainting for many years.

6. **Other Systems:** With air emission volatile organic compounds (VOC) restrictions being put in place around the nation, alternative coating systems may become available which would be viable options for this tank. The Owner should review the available systems prior to preparing specifications for the recoating project.

7. **Coating Curing:** It would be more economical to paint the tank exterior at the same time .the interior is painted, since the tank must be drained while the exterior is painted, and the applied coatings cure. This will also reduce mobilization and observation costs.

8. **Rehabilitation Schedule:** To obtain the lowest possible prices for the work outlined in the recommendations, the Owner should have the specifications prepared and the work bid in the early fall, with the work scheduled to start in early winter.

9. **Grinding and Bracket Removal:** Any unused brackets or erection lugs should be removed prior to the exterior repainting. Any weld burrs, weld spatter, or erection scars should be ground off to provide a smooth surface for the application of the coating.

10. **Level Indicating Device:** TCEQ requires that the tank be equipped with a level indicating device. No such device was observed during the field evaluation. A new water level indicating device satisfying these requirements should be installed on the tank.

11. **Existing Shell Manholes:** At the time of recoating and repairs, the gaskets for the shell manholes should be replaced. The covers for the shell manholes should be equipped with exterior hinged support arms. The "Confined Space" warning sign that was peeling off of the shell manhole cover should be replaced,

12. **Overflow Pipe:** Overflow pipes on the interior of tanks are exposed to the potential of ice damage and accelerated corrosion and metal loss rates. This results in the potential of pipe damage and an unanticipated tank draining. Additionally, overflow pipes without visible air breaks allow for a potential cross-connection. Therefore, Tank Industry Consultants and the AWWA Standard Dl00 recommend relocating the pipe to the tank exterior. The overflow pipe should exit the top shell ring and extend to approximately 24 in. above grade attached to the shell by welded steel brackets. The overflow pipe discharge should be equipped with a screened, counter-weighted flap gate or elastomeric check valve to prevent the ingress of birds, small animals and insects into the tank. The air break should be adequately sized to allow the proper functioning of the new flap gate. The overflow effluent should be directed away from the foundation using the existing concrete splash block.

13. **Exterior Ladder:** The exterior ladder should be replaced with a ladder which meets current requirements. A safe-climbing device should be installed on the ladder. The exterior ladders did not include slip-resistant rungs. Slip-resistant rungs are required for all ladders constructed after March 1991 by the OSHA Construction standards. However, slip-resistant rungs are not required by the OSHA General Industry standards for ladders or by AWWA D100.

14. **Vandal Deterrent:** The addition of side plates on both sides of the ladder at the existing vandal deterrent would offer the Owner further protection from unauthorized access to the ladder and tank.

15. **Roof Safety Railing:** The toe bar on the existing roof safety railing should be lowered so that the gap between it and the roof is no larger than 1/4 in. The access opening at the ladder should be equipped with removable closure chains.

16. **Clog Resistant Vent:** The tank was not equipped with a clog-resistant vent. AWWA Standards recommend that all vents with screening against insects be designed to ensure "fail-safe" operation if the insect screens become occluded. Inadequate ventilation could cause a tank collapse if the tank is rapidly drained while the screen is occluded or frosted over. Therefore, a clog-resistant vent should be installed on the roof in such a way that the rafters and center hub on the interior of the tank will not interfere with its operation. The vent should be designed so that it is removable in order to act as a second means of access to the tank interior. Until such time as the vent can be replace vertical shields should be installed and the rusty bolts replaced.

17. **Additional Roof Manhole:** OSHA and safety-related standards require a second roof manhole for emergency egress during coating and repairing operations: Therefore, a second roof manhole should be installed in the roof. The manhole and cover should be designed in accordance with current industry and safety standards. The new roof manhole should be installed between roof structure to allow unrestricted use of the manhole. Both the new and the existing roof manholes should be locked at all times to prevent unauthorized access to the tank interior.

C. Interior Surfaces

1. **Life of the Interior Coating:** The interior coating system appeared to be in generally poor overall condition. Corrosion, metal loss, and coating failures were widespread over the interior surfaces. Tank Industry Consultants recommends that the interior surfaces of this tank should be recoated in 1 to 2 years. It is recommended that when the interior is completely cleaned and repainted, an epoxy coating system should be used.

2. **Coating Testing:** Prior to preparation of specifications for the cleaning and coating of the interior of the tank, samples of the interior coating system should be subjected to laboratory analysis to test for ingredients which may at that time be subject to regulations concerning their handling and disposal.

3. Recommended Interior Coating System:

a. **Epoxy Coating System:** The optimum long-life coating system presently available for the interior of water tanks is a two-component epoxy coating system. A two-coat epoxy system is recommended for the interior of this tank. This coating system should meet the certification criteria of ANSL/NSF 61 and state department of health regulations.

b. **Coating Application:** When the interior is to be repainted, the entire tank interior should be cleaned to the equivalent of an SSPC-SP 10, Near-White Blast Cleaning and an epoxy coating system applied.

c. **Service Life:** The typical life of a properly formulated and applied epoxy coating system is approximately 12 to 15 years in immersion service. Tank Industry Consultants defines the life of a coating as the expected service life before repainting becomes necessary due to coating failure and corrosion. The Owner could extend the service life· of the coating by installing, properly maintaining and operating a cathodic protection system to help protect the steel surfaces in areas which have experienced coating failure.

4. **Cathodic Protection:** When the tank is rehabilitated the brackets and fittings should be installed for the future installation of a cathodic protection system.

a. **Type:** When the cathodic protection system is installed, an ice-resistant cathodic protection system which features long-life anodes, automatic potential and current control should be specified.

b. **Scheduling:** After the interior is completely cleaned and recoated, the cathodic protection system should not be energized until after the First Anniversary Evaluation. The Owner should conduct washouts and evaluations approximately every 3 years to monitor the need for cathodic protection. As the interior coating begins to show signs of failure, the cathodic protection system should be energized to aid in minimizing corrosion below the top capacity level.

c. **Maintenance:** Cathodic protection, if used and maintained properly, will control active corrosion below the water level and extend the useful life of a coating system. It should be noted that maintenance as recommended by the cathodic protection manufacturer is required for

the cathodic protection system to work properly. Without proper monitoring, the cathodic protection system may operate too high and cause the coating to blister, or the system may operate too low and not adequately protect the exposed steel surfaces.

5. **Pit Welding and Pit Filling:** After initial cleaning, all significant pitting which is found should be welded, and all pitting with rough edges that would make the pitting difficult to coat properly should be filled with a solventless epoxy seam sealer. (It was estimated that approximately 4 gallons of seam sealer will be required for pit repair.)

6. **Seam Sealing:** The existing roof manhole and new roof vent intersections should be sealed with an epoxy seam sealer at the time of the interior recoating.

7. **Rough Edges:** All unused brackets should be removed from the interior and exterior surfaces at the time of the next recoating. Any weld burrs, spatter, scars or rough edges in the steel should be ground smooth to provide a better surface for coating.

8. **Interior Ladder:** Interior ladders may be susceptible to ice damage and accelerated rates of corrosion. If the Owner decides to keep the interior ladder, the ladder should be replaced by a ladder which complies with current industry standards and should be equipped with a corrosion-resistant safe-climbing device.

9. **Roof Support Structure:** After abrasive blast cleaning, the roof support structure should be carefully evaluated as metal loss repairs may be necessary at areas where the metal loss was not previous visible.

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Tank Industry Consultants has no control over the cost of labor, materials, or equipment, or over the contractors' methods of determining prices, or over competitive bidding, or the market conditions. Opinions of probable cost, as provided for herein, are to be made on the basis of our experience and qualifications and represent our best judgment as design professionals familiar with the design, maintenance, and construction of concrete and steel plate structures. However, Tank Industry Consultants cannot and does not guarantee that proposals, bids, or the construction cost will not vary from opinions of probable cost prepared for the Owner.

Due to the numerous potential scopes of work which exist, the Owner should obtain an updated budget estimate once the final scope of work has been determined. This would enable the Owner to accurately budget monies for additional mobilization costs and damaged coating rehabilitation costs.

Engineering and resident observation costs are not included in the Total of the Engineer's Recommendations because these fees are dependent upon the scope of work to be performed. Tank Industry Consultants performs all facets of the engineering services which would be required for this project. Estimated fees for engineering and resident observation will be furnished upon request.

CLOSURE:

Brief Summation: The City of Stephenville owns and operates a 750,000 gallon ground storage tank in Stephenville, Texas. Areas of top coating on the exterior had peeled to the underlying coating. Tank Industry Consultants recommends that the exterior be recoated in the next 3 to 5 years. Coating failures were widespread over the interior surfaces. Large areas of the interior coating had peeled to the underlying coating. Heavy corrosion and metal loss were observed on the interior surfaces. Tank Industry Consultants recommends that the interior surfaces be recoated in the next 1 to 2 years. Proper maintenance after completing the recommendations herein would include periodic washouts and evaluations approximately every 3 to 5 years in accordance with AWWA recommendations and annual TCEQ evaluations.

Contractor Selection: The work should be performed by a competent bonded contractor, chosen from competitive bids taken on complete and concise specifications. The coatings used should be furnished by an experienced water tank coating manufacturer, supplying the field service required for application of technical coatings.

Standards for Repairs and Coatings: All work done and coatings applied should be applied in accordance with TCEQ, NACE, ANSI/NSF Standard 61, the manufacturer's recommendation, AWWA D100 and AWWAD 102 (latest revisions), and the SSPC: The Society for Protective Coatings.

Observation of Work: Observation of the work in progress by experienced personnel will offer additional assurance of quality protective coating application. Observations can be performed on a continuous basis or spot (critical phase) basis. The actual cost of observation may be less using spot as opposed to full-time resident observation; however, with spot observation it is often necessary for work to be redone to comply with the specifications. This somewhat lowers the quality of the finished product, lengthens the job, and is frequently a cause of conflict between the contractor, Owner, and field technician. Resident full-time observation minimizes the amount of "rework" required.

Anniversary and Maintenance Evaluations: An anniversary evaluation should be conducted prior to the end of the one year bonded guarantee. Washouts and coating, structural, sanitary, safety, and corrosion evaluations should be conducted not less than every three years.

Time Frame: If the work is not performed within the next 12 months, the structure should be reevaluated prior to the preparation of specifications and solicitation of bids.

Specifications and Bidding Documents: The recommendations in this report are not intended to be specifications on which a contractor can bid. Complete bidding documents must include general and special conditions, detailed technical specifications, and other information necessary for the competitive bidding process. To properly protect the interests of the Owner, Contractor, and Engineer; the initial evaluation, the technical specifications, legal portions of the contract documents, and the observation should be performed by the same firm or with close coordination of all parties involved.

Limitations of Evaluation: It is believed that the conditions reported herein reflect the condition of the tank as observed on the date of the evaluation, using reasonable care in making the observations, and safety in gaining access to the tank. Should latent defects be discovered during the cleaning of the structure, they should be brought to the attention of the Owner and the Engineer.

Seismic and Wind Loadings: This tank is located in or near a region of low seismic activity. This evaluation and the reporting of the condition of this tank do not warrant the structural condition of the tank or any of the original design for seismic loadings. Likewise, recommendations for this tank do not include modifications which may be required for compliance with present structural codes. It is possible the tank was erected in compliance with pre-existing industry standards which have since been replaced by more restrictive standards.

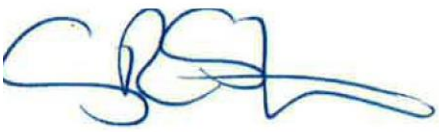
Hazardous Materials in Coatings: Samples taken of the coatings on the exterior of this structure indicated a presence of lead (and possible other heavy-metal) pigments; It should be taken into consideration that Federal, State, and local environmental agencies have placed stricter controls on the removal of lead-based and other heavy-metal based coatings from steel structures by the use of conventional abrasive blasting techniques. The paint and blast residue may be considered to be hazardous waste depending on the concentration of lead or other particles in residue.

Please contact Tank Industry Consultants if you have any questions or comments.

Respectfully submitted,

Tank Industry Consultants

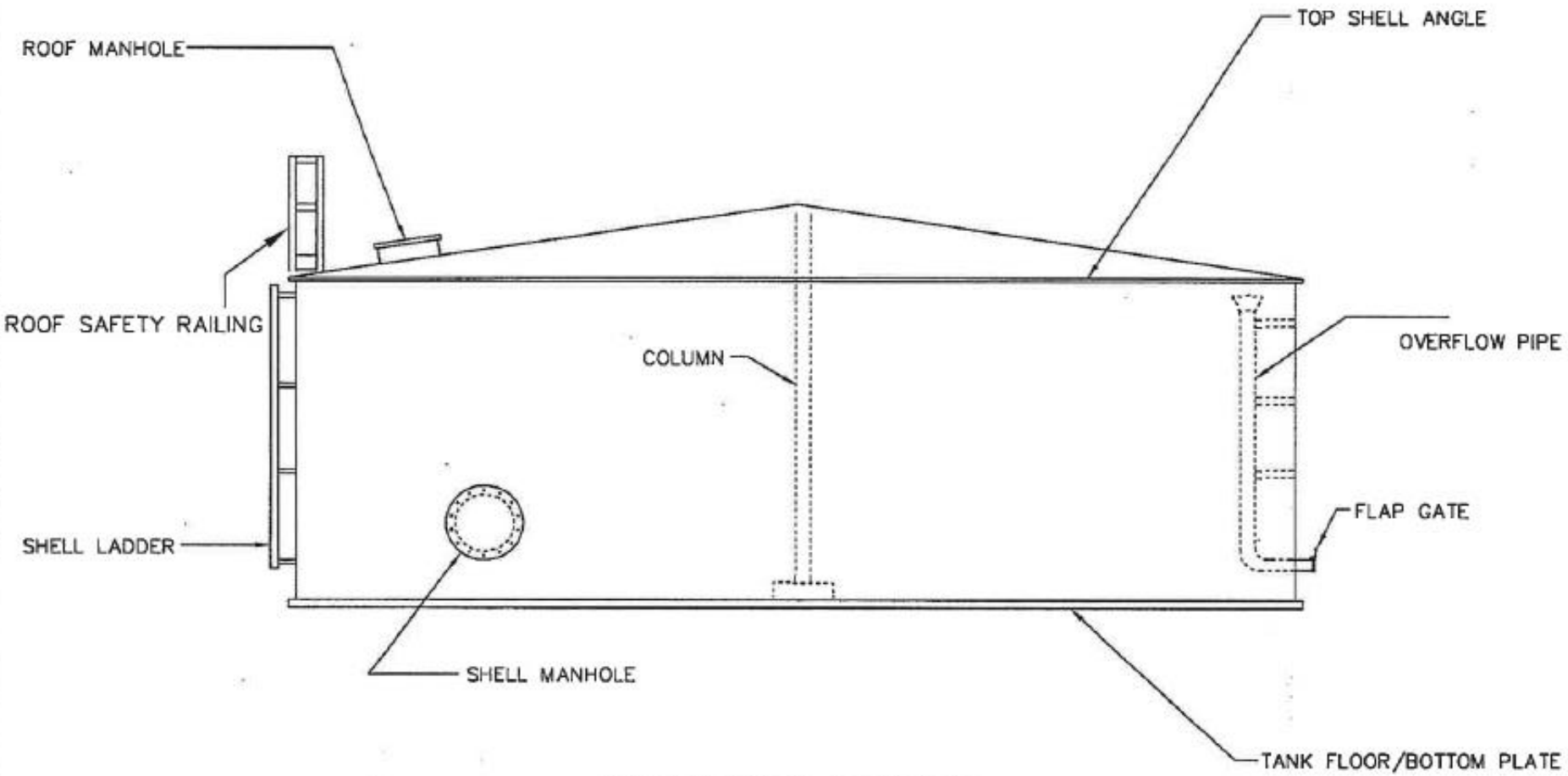
Joshua A. Selig, E.I.
Project Engineer



Gregory R. "Chip" Stein, P.E.
Managing Principal

Tank Industry Consultants
Registration Number F-2891

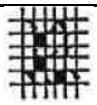
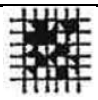
GROUND STORAGE TANK



NOMENCLATURE

Classification of Adhesion Test Results

Method A - X Cut Tape Test Approx. t.5 In. long cuts at 30 deg. to 45 deg. apart.	Surface	Classification
No peeling or removal		5
Trace peeling or removal along incisions.		4
Jogged removal along incisions up to 1/16 in. (1.6mm) on either side.		3
Jagged removal along most of incisions up to ·1/8 in. (3.2mm) on either side.		2
Removal from most of the area of the X under the tape.		1
Removal beyond the area of the X.		0

Method B - Lattice Cut Tope Test Six parallel cuts at 2mm apart.	Surface	Classification
The edges of the cuts are completely smooth; none of the squares of the lattice are detached.	No Failure	5
Small flakes of the cooling are detected at intersections; less than 5% of the lattice is affected.		4
Small flakes of the coating are detached along edges and at intersections of cuts. The area affected is 5% to 15% of the lattice.		3
The coaling hos flaked along the edges and on ports of the squares. The area affected is 15% to 35% of the lattice.		2
The coating has "flaked along the edges of cuts in large ribbons and whole squares have detached. The area affected is 35% to 65% of the lattice.		1
Flaking and detachment worse than grade 1.		0

ASTM 3359 Standard Test Methods for Measuring Adhesion by Tape Test

Tank Industry Consultants

7740 West New York Street
Indianapolis, Indiana 46214-

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- CERTIFICATE OF ANALYSIS -

Disp. Code: E I **Report Date:** *19-Feb-15 04:25 PM*

Client ID: TANK_INDUST

Tank Industry Consultants
7740 West New York Street
Indianapolis, Indiana 46214
Attn: Julie White

Phone: (317) 271-3100
FAX: (317) 271-3300

Our Lab # 15001998-001 **Your Sample ID:** Ext. Shell
Sample Composition: Grab

Your Project # 14237.S1508.002 **Collection Date:** 02/09/15
Your Project Name: Paint Sample **Collected By:** Client
Sample Type: Paint Chips **Receipt Date:** 02/17/15 10:30

Total Metals, ICP-AES

Analytical Method	Prep Method	Prep Date	By
SW846 6010B	SW846 3050B	2/18/2015	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Cadmium, Cd	< 25.0	mg/kg		25.0	7440-43-9	02/19/15	spotts
Chromium, Cr	1570	mg/kg		250	7440-47-3	02/19/15	spotts
Lead, Pb	69000	mg/kg		2500	7439-92-1	02/19/15	spotts

Our Lab # 15001998-002 **Your Sample ID:** Int. Shell
Sample Composition: Grab

Your Project # 14237.S1508.002 **Collection Date:** 02/09/15
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Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Cadmium, Cd	< 25.0	mg/kg		25.0	7440-43-9	02/19/15	spotts
Chromium, Cr	< 250	mg/kg		250	7440-47-3	02/19/15	spotts
Lead, Pb	< 250	mg/kg		250	7439-92-1	02/19/15	spotts

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2/19/2015

Lab Manager **Date**

Lab # 15001998-002 **Sample ID:** Int. Shell

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