TANK INDUSTRY CONSULTANTS

EVALUATION OF THE

3,000,000 GALLON STEEL GROUND STORAGE TANK

"STROTHERS LANE TANK"
WINCHESTER, VIRGINIA

FOR

HAZEN & SAWYER, P.C.
NEWPORT NEWS, VIRGINIA

August 15, 2017

17.125.E954.005

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SUBJECT:

The subject of this report is the field evaluation of the 3,000,000 gallon steel ground storage tank in Winchester, Virginia. The tank was owned by the City of Winchester and was known as the "Strothers Lane Tank." The field evaluation was performed on August 15, 2017 by Gregory P. Cannon, NACE Coating Inspector Level 3 Certified, Certificate No. 10339, and Jamie L. Stewart, NACE Coating Inspector Level 3 Certified, Certificate No. 64809 of Tank Industry Consultants. The Owner's representatives on the site at the time of the field evaluation were Joel Petery and Donnie Johnston. The column and rafter supported roof tank was of welded steel construction. Measurements taken at field evaluation indicated the tank was approximately 120 ft in diameter with a shell height of approximately 36 ft 5 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 an electronic mail message sent to Nicole Clarke of Tank Industry Consultants dated July 27, 2017.

EXECUTIVE SUMMARY:

The coating on the exterior was in very poor condition with widespread areas of peeled coating and corrosion noted. The exterior should be repainted within the next 2 to 3 years. The interior coating was in good overall condition. Any nuts or bolts missing from the roof support structure should be replaced immediately.

Structural Deficiency: There was a structural deficiency observed on this tank:

- a welded steel door sheet in the shell did not contain rounded corners.

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

- the valve vault access rung width was too small (29 CFR 1910.23(b)(4)),
- the valve vault ladder rungs were not all spaced at consistent intervals no more than 14 in. apart (29 CFR 1910.23(b)(1) and (2)),
- the valve vault head clearance was too small (29 CFR 1910.23(d)(13)(ii)),
- the paint on the exterior ladder safe-climbing device may not allow the device to function properly,
- the offset design of the exterior ladder safe-climbing device may prevent its proper operation,
- the vandal deterrent was not equipped with side panels to prevent unauthorized access up the back of the exterior ladder,
- the exterior ladder side rails were too small (ANSI A14.3),
- the exterior ladder rungs were not spaced at intervals no more than 14 in. apart (29 CFR 1910.23(b)(2)),
- conduits were attached to the exterior ladder brackets which could interfere with the unrestricted use of the side rails by the climber (29 CFR 1910.23(d)(13)(i)),
- the spacing between vertical bars on the exterior ladder safety cage exceeded the maximum allowed (29 CFR 1910 Subpart D – Figure D-15),
- the base of the exterior ladder safety cage was not flared (29 CFR 1910 Subpart D – Figure D-15),
- the roof was not equipped with safety railing to deter personnel from inadvertently falling (29 CFR 1910.28(b)(1)),
- the interior ladder side rails were too small (ANSI A14.3),
- the interior ladder rungs were not spaced at intervals no more than 14 in. apart (29 CFR 1910.23(b)(2)),
- the depth of the interior ladder safety cage exceeded the maximum allowed (29 CFR 1910 Subpart D – Figure D-15), and
- the spacing between vertical bars on the interior ladder safety cage exceeded the maximum allowed (29 CFR 1910 Subpart D – Figure D-15).

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

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

- the target gage cable penetration through the roof was not sealed and could allow runoff water or insects into the interior,
- the cover overlap on the third roof manhole was too small,
- the roof vents were not of a clog-resistant design,
- gaps between the center roof vent screening and cover could allow the ingress of insects into the tank,

- a hole was located in the cover of one of the roof vents which could allow the ingress of insects and runoff water into the tank,
- flanges in the conical cover roof vents were not equipped with gaskets,
- the screening on the roof vents was not shielded from wind-driven dust and debris,
- the size of the screening on the conical cover roof vents was not adequate to prevent the ingress of insects into the tank
- interior overflow pipes are susceptible to ice damage and accelerated rates of corrosion,
- the overflow pipe did not contain a visible air break above grade, and
- what appeared to be lead joint was located at the outlet pipe penetration through the floor.

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 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 0 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%	4,230	0.423%	134,000	13.4%
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. 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 THICKNESS MEASUREMENTS:

(all readings were taken through coating)

Roof Plates:	0.273 in. to 0.278 in.
Shell:	
Ring #5:	0.301 in. to 0.304 in.
Ring #4:	0.421 in. to 0.424 in.
Ring #3:	0.585 in. to 0.588 in.
Ring #2:	0.820 in. to 0.827 in.
Ring #1:	1.010 in. to 1.013 in., bottom
Bottom Plate:	0.261 in. to 0.266 in.

OBSERVATIONS:

A. Foundation and Site

SITE:
Size: approx. 125 ft x 195 ft

Nearest Structures:
Type: shed
Direction: south
Distance: approx. 1 ft 7 in.

Type: ground storage tank
Direction: east
Distance: approx. 66 ft

Type: building
Direction: southeast
Distance: approx. 325 ft

Nearest Overhead Power Lines:
Direction: south
Distance: approx. 50 ft

FOUNDATION:
Type: concrete ringwall
Projection Above Grade:
North: 8 in. to 11-1/2 in.
South: 8 in. to 21-1/2 in.
East: 5-1/2 in. to 13 in.
West: 8 in. to 10 in.
Grout: none visible
Sealant: bituminous

VALVE VAULT:
Location: attached to south side of tank
Size: 7 ft 6 in. x 10 ft x 7 ft 6 in. deep
Access:
Size: 24 in. x 30 in.
Locked: yes
Access Rungs:
Rung Size: 1 in.
Width: 8-1/2 in.
Spacing: 14-3/4 in. to 15-1/4 in.
Head Clearance: 24-1/2 in.

1. **Site Location**: The tank was accessed from the end of Strothers Lane in Winchester, Virginia. Wooded areas surrounded the site. Overhead power lines were located to the south. (See photos 2-4)

2. **Site Conditions**: The tank site was covered with grass and was graded to provide adequate drainage away from the foundation. The tank site was not fenced. What appeared to be blast media was found on the ground surrounding the tank. Tree limbs were growing in close proximity to the tank. A hydrant was located on the south part of the site. Failed coating chips were located on the ground around the tank. (See photos 1, 11)

3. **Foundation**: The tank foundation appeared to be a concrete ringwall. Much of the foundation was covered with sealant limiting the surfaces which could be viewed. Cracking, spalling, erosion, and small surficial holes were observed in the concrete foundation at the time of this field evaluation. The foundation sounded hollow when struck. The foundation exhibited the AWWA recommended 6 in. to 12 in. projection above grade, and exceeded it in other areas. Coating was visible on the exposed concrete surfaces at the time of this field evaluation. (See photos 12-14, 16)

4. **Sealant**: There was a thick bituminous-based sealant located around the bottom plate and foundation which was in poor condition. Cracking was observed in numerous areas, and gaps measuring up to 1 in. wide were present in the sealant. The sealant prevented visibility of the bottom plate-to-foundation interface. (See photos 13-14)

5. **Valve Vault: There were safety and OSHA deficiencies noted: (1) the 8-1/2 in. access rung width did not meet the required 16 in. minimum, (2) the 14-3/4 in. to 15-1/4 in. spacing between access rungs did not comply with the requirement for rungs to be spaced at consistent intervals no more than 14 in. apart, and (3) the 24-1/2 in. head clearance did not meet the minimum required 30 in.** There was a valve vault attached to the south side of the foundation. Access into the valve vault was locked prior to or after this field evaluation. The piping in the valve vault was generally rust covered, with layering corrosion and metal loss on piping nuts and bolts. A drain was located in the vault floor. (See photos 5-10)

B. Exterior Surfaces

DESCRIPTION:

Construction: welded steel
Diameter: approx. 120 ft
Shell Height: approx. 36 ft 5 in.
Shell Rings: 5
Roof Type: column and rafter supported

BOTTOM PLATE PROJECTION: approx. 1 in. to 2-3/4 in. from shell

SHELL MANHOLES:

Number: 2

Location: south side of shell ring #1

Type: single-crab

Size: 24 in. diameter

Neck: 7 in. projection from shell x 7/8 in. thick

Bolt: 1 in. diameter x 8 in. long

Cover Plate:

Size: 26-1/4 in. diameter x 1 in. thick

Hinged: yes

Location: north side of shell ring #1

Type: flanged and bolted

Size: 23-1/4 in. diameter

Neck: 13-1/2 in. projection from shell x 0.456 in. to 0.461 in. thick

Flange: 33 in. O.D x 5/8 in. thick

Bolts:

Number: 28

Size: 3/4 in. diameter x 3 in. long

Cover Plate:

Size: 33 in. diameter x 3/4 in. thick

Hinged: no

SHELL LADDER:

Number of Rungs: 20

Distance From Ground to Lowest Rung: 12 ft 10 in.

Width: 29-1/4 in.

Side Rails: 2 in. x 3/8 in., flat bar

Rung Size: 3/4 in. diameter

Spacing: 15 in. on center

Toe Room: 7 in.

Brackets:

Construction: welded

Size: 2 in. x 3/8 in., flat bar

Spacing: approx. 4 ft

Safe-Climbing Device: 3/8 in. diameter cable-type

Safety Cage:
Depth: 27-3/4 in.
Width: 30-1/2 in.
Vertical Bars:
Size: 1-1/2 in. x 3/8 in., flat bar
Spacing: 13-1/2 in. on center
Horizontal Bars:
Size: 2 in. x 3/8 in., flat bar
Spacing: 47-3/4 in. on center
Vandal Deterrent:
Size: 29-1/2 in. x 38 in.
Locked: yes

ROOF SAFETY RAILING: none

ROOF OPENINGS:
Manhole #1:
Size: 30 in. square
Type: hinged
Curb: 6 in. x 1/4 in. thick
Welded: exterior only
Overlap: 2 in. x 1/4 in.
Locked: yes

Manhole #2:
Size: 36 in. square
Type: hinged
Curb: 6 in. x 1/4 in.
Welded: exterior only
Overlap: 2 in. x 1/4 in.
Locked: yes

Manhole #3:
Size: 27 in. x 26-1/2 in.
Type: hinged
Curb: 6 in. x 1/4 in.
Welded: exterior only
Overlap: 1-1/4 in. x 1/4 in.
Locked: yes

Roof Vent #1:
Type: mushroom cover
Neck Height: 12 in.
Neck Diameter: 24 in.
Screen:
Orientation: vertical
Size: 16 x 16 mesh and expanded metal
Cover: 36 in. diameter

Vents #2 and #3:
Type: conical cover
Neck Height: 22-1/2 in. to 23 in.
Neck Diameter: 14 in.
Screen:
Orientation: vertical
Size: expanded metal
Cover: 20 in. diameter

EXTERIOR COATING AND METAL CONDITION:

	Coating Thickness		Approx. % Failure to		Adhesion	Metal Loss	
	Range	Typical	Underlying Coating	Rust		Typical	Deepest
Shell	11.7 mils to 42.5 mils	30 mils	1%	< 3%	0 S	Neg.	Neg.
Roof	10.6 mils to 41.2 mils	16.5 mils	1%	< 1%	0 S	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 blue coating on the exterior of the tank appeared to be in very poor condition and was providing inadequate corrosion protection to most of the underlying steel. The exterior coating exhibited very poor adhesion to the underlying steel. The finish coat had cracked and peeled away from the underlying coating in areas. The coating appeared to be an alkyd coating system. It appeared the exterior surfaces had been spot cleaned and topcoated previously.

2. **Bottom Plate**: Most of the bottom plate exterior projection was obscured by the presence of sealant. Corrosion and peeled coating were located on the visible surfaces. (See photos 13, 15)

3. **Shell Condition**: **There was a structural deficiency noted: a welded steel door sheet in the shell did not contain rounded corners.** The contour of the tank shell was generally poor with widespread banding and flat areas observed. The coating appeared to be in poor overall condition with large areas of peeled coating and corrosion. The coating exhibited very poor adhesion to the steel.

Runs, drips, and debris were located in the coating, and mildew was present. It appeared the shell had been topcoated previously. A rail was located near the top of the top shell ring. The exterior rail was bolted to brackets which were welded to the shell. The rail exhibited poor contour but was in good overall condition. An approximately 7 ft x 7 ft 6 in. welded steel door sheet was located in the south side of the bottom shell ring. The welded steel door sheet did not include rounded corners. There were several abandoned brackets and studs on the lower part of the south shell, as well as an unused angle bracket on the lower part of the west shell. **The exterior rail should not be used for rigging purposes.** (See photos 17-25, 33-35)

4. **Water Level Indicating Device**: **There was a sanitary deficiency noted: the device cable penetration through the roof was not sealed and could allow rain water or insects into the interior.** A target gage was located on the shell, and equipment for the cage penetrated the roof. The penetration was not sealed which could allow the ingress of insects or run-off water into the tank. The device appeared to be capable of operating properly. (See photos 29-30, 34, 43)

5. **Shell Manholes**: The tank was equipped with one flanged and bolted circular manhole located on the north side of the shell, and one single-crab circular manhole located on the south side of the shell. The shell plate around each of the manholes was equipped with a circular reinforcing plate. The south manhole cover was equipped with a hinged support located on the interior of the tank while the north manhole cover did not have a hinged support. (See photos 27-28)

6. **Exterior Shell Ladder: There were safety and ANSI/OSHA deficiencies noted: (1) the paint on the safe-climbing device may not allow the device to function properly, (2) the offset design of the safe-climbing device may prevent its proper operation, (3) the 2 in. x 3/8 in. side rails did not meet the required minimum of 2-1/2 in. x 3/8 in. side rails, (4) the vandal deterrent was not equipped with side panels to prevent unauthorized access up the back of the exterior ladder, (5) the ladder rungs were not spaced at intervals no more than 14 in. apart, (6) conduits were attached to the ladder brackets which could interfere with the unrestricted use of the side rails by the climber, (7) the 13-1/2 in. spacing between vertical bars on the safety cage exceeded the maximum allowed 9-1/2 in., and (8) the base of the safety cage was not flared.** A ladder provided access from a height of approximately 13 ft from the ground to the roof. The ladder was equipped with a cable-type safe-climbing device, but the device had been painted and was installed such that it may not operate properly. 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 safety cage which was constructed of welded flat bar members. The base of the ladder was equipped with a swinging gate vandal deterrent. Terminals were located at the ladder access to the roof. An antenna was attached to the top of the ladder safety cage. (See photos 31-32, 36)

7. **Roof Safety Railing: There was a safety-related or OSHA deficiency noted: the roof access was not equipped with safety railing to deter personnel from inadvertently falling from the roof.**

8. **Roof Condition**. The contour of the roof was irregular with evidence of trapped water noted. The roof coating was in poor condition with widespread areas of cracked and peeled coating and corrosion noted. The coating had chalked and checked, and debris and drips were observed in the coating. The coating on the roof exhibited very poor adhesion to the steel. A solar panel and cabinet

for the interior mixer were located on the roof. A bird deterrent was located on the top of these. A sensor and what appeared to be an abandoned conduit were located on the roof adjacent to the south manhole. Forty-one welded steel patch plates, presumably for a previous cathodic protection system, were located in the roof. (See photos 37-42, 44, 47-48)

9. **Roof Manholes: There was a sanitary and AWWA deficiency noted: the 1-1/4 in. overlap on the third roof manhole cover did not meet the minimum required 2 in.** The roof was equipped with three manholes. All of the manholes were equipped with hinged and locked covers. The roof manholes were welded on the exterior only. (See photos 50-52)

10. **Roof Vents: There were sanitary and operational deficiencies noted: (1) the roof vents were not of a clog-resistant design, (2) gaps between the center vent screening and cover could allow the ingress of insects into the tank, (3) a hole was located in the cover of one of the vents which could allow the ingress of insects and runoff water into the tank, (4) the conical cover vents were not equipped with gaskets, (5) the screening on none of the vents was shielded from wind-driven dust and debris, and (6) the size of the screening on the conical cover vents was not adequate to prevent the ingress of insects into the tank.** The roof was equipped with three vents such that the center one had a mushroom cover and the other two had conical covers. The conical cover vents were attached to flanged openings. The flanges were not equipped with gaskets. The size of the screening on the conical cover vents could allow the ingress of insects into the tank. The center vent was equipped with a layer of fine mesh screening and expanded metal. However, gaps at the center vent screening could allow the ingress of insects. The vertically oriented screening on each of the vents was not completely shielded from wind-driven dust and debris. (See photos 45-46, 49)

C. Interior Surfaces

ROOF SUPPORT SYSTEM:
- Rafters:
  - Number:
    - Inner: 20
    - Middle: 40
    - Outer: 60
  - Size: 8 in. x 2-1/4 in., channel
- Purlins: approx. 1/2 in. diameter
- Center Hub: approx. 3 ft diameter x 1 in. thick plate

Center Column:
Type: two channels intermittently welded together to form a T-shape
Channel Size: 9 in. x 2-1/2 in. and 7 in. x 2-1/8 in.
Base Supports:
Channels: 8 in. x 2-1/4 in.
Triangles: 6 in. x 12-1/2 in. x 1/4 in.
Flat Bars: 2-1/2 in. x 3/8 in.
Angles: 2-1/2 in. x 2-1/2 in. x 3/8 in.
Outer Columns:
Number: 15
Type: two channels intermittently welded together to form a T-shape
Channel Size: 9 in. x 2-1/2 in. and 7 x 2-1/8 in.
Base Supports:
Channels: 8 in. x 2-1/4 in.
Triangles: 6 in. x 12-1/2 in. x 1/4 in.
Flat Bars: 2-1/2 in. x 3/8 in.
Angles: 2-1/2 in. x 2-1/2 in. x 3/8 in.

TOP SHELL ANGLE:
Size: 3 in. x 3 in. x 3/8 in.
Orientation: leg in

INTERIOR LADDER:
Number of Rungs: 29
Width: 29-1/4 in.
Rung Size: 3/4 in. diameter
Spacing: 14-3/4 in. on center
Side Rails: 2 in. x 3/8 in., flat bar
Toe Room: 9-1/4 in.
Head Clearance: 33 in.
Brackets:
Construction: welded
Size: 2 in. x 3/8 in., flat bar
Spacing: 4 ft
Safe-Climbing Device: none
Safety Cage:
Depth: 28-1/4 in.
Width: 29-1/2 in.
Vertical Bars: 4
Size: 1-1/2 in. x 3/8 in., flat bar
Spacing: 16 in. on center
Horizontal Bars:
Size: 2 in. x 3/8 in., flat bar
Spacing: 47 in. on center

OVERFLOW PIPE:
- Size: 6 in. diameter
- Location: approx. 12 in. below shell-to-roof connection
- Inlet Type: open pipe, flanged
- Brackets:
  - Size: 3 in. x 1/2 in., flat bar
  - Spacing: approx. 10 ft

INTERIOR PIPING:
- Inlet Pipe:
  - Size: 8 in. diameter
  - Projection: approx. 25 ft above floor
  - Brackets:
    - Size: 3 in. x 1/2 in., flat bar
    - Spacing: approx. 20 ft
  - Protective Cover: none

- Outlet Pipe:
  - Size: 10 in. diameter
  - Projection: 3/4 in. above floor
  - Protective Cover: none

INTERIOR COATING AND METAL CONDITION:

	Coating Thickness		% Failure to		Adhesion	Metal Loss	
	Range	Typical	Primer	Rust		Typical	Deepest
Roof	10.3 mils to 17.1 mils	13.5 mils	Neg.	< 1/2%	3 S	Neg.	Neg.
Shell	11.1 mils to 26 mils	17 mils	Neg.	Neg.	3 S	Neg.	Neg.
Floor	9.6 mils to 20.3 mils	10 mils	Neg.	Neg.	3 S	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. **Interior Coating Condition**: The beige coating on the interior surfaces of the tank appeared to be in good overall condition and providing adequate protection from corrosion to most of the underlying steel. Widespread areas of metal loss had been coated over in the roof with a few areas of active corrosion noted. The interior coating exhibited fair adhesion to the steel.

2. **Roof Condition**: The coating on the roof plates appeared to be in generally good condition. The interior roof support structure consisted of a center column, two circles of columns, three sets of rafters, purlins, and two sets of circumferential girders. The inner ends of the roof rafters were bolted to the top of a center hub which was located at the top of the center column. The columns

supported the circumferential girders on which the intermediate ends of the roof rafters rested. The outer ends of the rafters were bolted to steel clips which were welded to the shell. Rust staining was located along the top of the roof rafters with minor active corrosion and pack rust along lap seams. It appeared that previous pack rust had been painted over along the roof-to-shell connection, along the rafter flanges, purlins, rafter attachment clips to the shell, and the nuts and bolts in these areas. It appeared some of the nuts and bolts were no longer present. Rafters appeared to be slightly bowed and twisted. Each of the column bases was constructed of four channel members, two triangular plates, two angle clips, and a reinforcing floor plate. Each base was constructed of two parallel channels with two channels welded between them with triangular plates on top reinforcing the connection of the inner channels to the outer channels. The column base channels were intermittently welded to a reinforcing floor plate. One channel of the column was bolted to one of the inner base channels while the other column channel was bolted and welded to two angle clips which were bolted to the second inner base channel. Sensor equipment was located on the roof. (See photos 54-68, 72-77)

3. **Shell Condition**: The coating on the shell interior appeared to be in good overall condition. It appeared the coating had been touched-up previously. There was no significant coating failure or corrosion observed on the interior shell at the time of this field evaluation. Minor weld spatter and weld scars were located on the shell. Roller debris and overspray were present in the coating. A top shell angle was located around the roof-to-shell connection. Two abandoned lugs were located on the fifth shell ring on the east side of the tank. **The lugs should not be used for rigging purposes.** (See photos 68, 78, 82)

4. **Water Level Indicating Device**: A float and guide wires for the water level indicating device were located on the inside of the tank. The wires were attached and the device appeared to be capable of operating properly at the time of the field evaluation. (See photo 87)

5. **Interior Ladder: There were safety and ANSI/OSHA deficiencies noted: (1) the 2 in. x 3/8 in. ladder side rails did not meet the required minimum of 2-1/2 in. x 3/8 in. side rails, (2) the 14-3/4 in. ladder rung spacing exceeded the maximum allowed 14 in., (3) the 28-1/4 in. depth of the ladder safety cage exceeded the OSHA required 27 in. to 28 in., and (4) the 14-1/2 in. spacing between vertical bars on the safety cage exceeded the maximum allowed 9-1/2 in.** A ladder provided access from the roof manhole to the floor. The ladder was not equipped with a safe-climbing device but was equipped with a safety cage constructed of flat bar members. The interior ladder was welded to brackets which were welded to the shell. The interior ladder and brackets appeared to be in nearly their original structural condition at the time of this field evaluation. (See photos 52-53, 71)

6. **Overflow Pipe**: **There were sanitary and operational deficiencies observed: (1) interior overflow pipes are susceptible to ice damage and accelerated rates of corrosion, and (2) the pipe did not contain a visible air break above grade.** The overflow was equipped with an open flange type inlet and was located such that the top capacity level was below the shell-to-roof connection and rafter ends. The pipe extended down the shell before exiting the floor. The overflow pipe was flat bar banded to brackets which were welded to the shell. No significant corrosion was observed on the overflow pipe and brackets at the time of the field evaluation. (See photos 71, 80, 82, 85)

7. **Bottom Plate Condition**: The coating on the tank bottom appeared to be in good overall condition. No significant coating failures were observed on the interior floor at the time of this field evaluation although minor pin rust was located along the shell-to-floor connection. The coating had been touched-up previously, and it appeared pitting had been welded previously. A mixing system was located within the tank which appeared capable of operating properly. (See photos 68-70, 79-80, 88)

8. **Interior Piping**: **There was a sanitary deficiency noted: what appeared to be lead joint was located at the outlet pipe penetration through the floor.** The outlet pipe projected slightly above the floor and was not equipped with a protective cover. The inlet pipe projected approximately 25 ft above the floor before ending in a "T"-shape. The inlet pipe was equipped with welded steel flat bar brackets, and no significant corrosion was observed on the pipe or brackets. The floor plates around the pipes were equipped with welded steel reinforcing plates. (See photos 71, 79, 81, 83-84, 86)

RECOMMENDATIONS:

A. Foundation and Site

1. **Site Maintenance**: The site should be maintained 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 continues. 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. A fence should be installed and the gate should be locked at all times to deter unauthorized entry and limit liability for the Owner. The surrounding tree branches should be regularly trimmed so they do not come into close proximity with the tank. The failed coating pieces should be removed from the site as soon as possible.

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. In addition to the installation of a site fence, other security measures might include installing no-trespass signs, site lighting, motion detectors, surveillance cameras, 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. **Sealant Maintenance**: When the exterior repainting is performed, the existing sealant located between the bottom plate and the foundation should be removed and replaced with a flexible polyurethane sealant.

5. **Valve Vault**: The access rungs should be replaced with rungs which meet current requirements. 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 continue to 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. Specifications should be written to anticipate the replacement of the piping nuts and bolts.

B. Exterior Surfaces

1. **Life of the Exterior Coating**: The exterior coating system appeared to be in very poor condition and not providing adequate corrosion protection to the steel surfaces. Tank Industry Consultants believes that the exterior of the tank should be repainted within the next 2 to 3 years from a corrosion standpoint or sooner if aesthetics are of concern. Due to the very poor adhesion of the existing exterior coating and extent of coating failure noted, 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 will be required, and containment of paint droplets will be required.

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 the 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 spring, with the work scheduled to start in early summer (if possible).

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. **Electrical Apparatus**: All unused electrical conduit, antennas, fixtures, electrical metering equipment, and control cabinets should be removed from the tank and tank site. All required equipment should be repaired and maintained in accordance with the National Electric Code (NEC).

11. **Door Sheet**: The welded steel door sheet should be replaced with one which includes rounded corners in accordance with current industry standard practices.

12. **Exterior Shell Rail**: Calculations should be performed to determine if the exterior rail can be removed. If it can be removed, it should be. **The exterior rail should not be used for rigging purposes.**

13. **Water Level Indicating Device**: The penetration for the target gage at the roof should be sealed.

14. **Existing Shell Manholes**: At the time of recoating and repairs, the gaskets for the shell manholes should be replaced. The hinged support arm on the south manhole should be relocated to the exterior of the tank, and the north manhole cover should be equipped with a hinged support arm also located on the exterior of the tank.

15. **Additional Shell Manhole**: Tank Industry Consultants interprets OSHA standards as defining a water storage tank as a confined space, and as such, a sufficient means of emergency egress and ventilation during cleaning and coating operations is required. Therefore, it is recommended the tank be equipped with a third hinged shell manhole. The additional manhole and cover should be 30 in. in diameter, should be designed in accordance with current industry and safety standards, should be hinged, and should be located equidistant from the existing shell manholes.

16. **Exterior Ladder**: The exterior ladder should be replaced with a ladder which meets current requirements. In addition, the safety cage is not required on ladders with safe-climbing devices. To reduce cleaning and painting costs and future maintenance costs, because the existing safety cage is not OSHA compliant, and because OSHA is phasing out the use of the safety cages in lieu of the installation of safe-climbing devices, the cage could be removed and the existing painted and improperly installed safe-climbing device replaced. The conduits should be relocated away from the side rails. The exterior ladder 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. When the roof safety railing is installed, the ladder terminals should be removed.

17. **Vandal Deterrent**: If the existing safety cage is removed, a new vandal deterrent should be installed.

18. **Roof Safety Railing**: Safety railing which meets current OSHA dimensional requirements should be installed at the roof access and adjacent to the roof manhole with a self-closing gate at its access.

19. **Clog-Resistant Vents**: The tank was not equipped with clog-resistant vents. 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, clog-resistant vents should be installed. The existing center vent opening should be equipped with a large flanged opening for evaluating, cleaning, repairing, and painting the interior roof structure ends at the center. Until such time as the new vents can be installed, the hole in one of the conical vent covers should be sealed. The flanges on the conical cover vents should be equipped with gaskets, and the conical cover vent screening replaced with more restrictive screening. The gaps in the center vent screening should be eliminated. The conical cover vents should be equipped with vertical shields.

20. **Existing Roof Manholes**: The existing roof manhole #3 dimensions did not comply with current AWWA standards. Therefore, this manhole should be modified to include a 2 in. overlapping cover. All of the roof manholes and covers should continue to be locked to improve water system security.

C. Interior Surfaces

1. **Life of the Interior Coating**: The coating on the interior surfaces of the tank appeared to be in good overall condition and providing adequate protection from corrosion to most of the underlying steel. Widespread areas of metal loss had been coated over in the roof with a few areas of active corrosion noted. When the tank is removed from service for exterior repainting, any nuts, bolts,

or members displaying significant metal loss should be replaced. Any missing nuts or bolts at the rafter connections should be replaced immediately. Any areas of coating damaged by these repairs should be touched-up. A cathodic protection system should then be installed. 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. **Cathodic Protection**: To prevent further corrosion and metal loss at the areas of coating failure below the top capacity level, a cathodic protection system should be installed.

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**: If the cathodic protection system is installed prior to complete cleaning and repainting the tank interior, the system should be removed and protected prior to cleaning and painting. 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.

4. **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.

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

6. **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.

7. **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.

8. **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 previously visible. Any missing nuts or bolts should be replaced immediately.

9. **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 D100 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 a concrete splash block, or if the Owner wants to continue to use the current underground piping, the vertical portion of the underground piping should be equipped with an air break and a large funnel to direct the overflow effluent into the pipe.

10. **Lead Joint Removal**: The suspected lead joint at the outlet pipe-to-floor penetration should be verified and removed or isolated from contact with the water.

ECONOMIC FACTORS:

Item	Cost	Life in Years
Replacement of tank with a new one	$ 4,500,000[1]	75+

The following is a complete list of repairs and estimated costs for their respective recommendations found in the RECOMMENDATION section of this report.

Item	Sanitary & Safety	Scheduled Maintenance Repairs
Clean and Paint Exterior:		
SP 6, Complete Clean, Epoxy/Polyurethane System		$ 400,000
Containment		100,000
[2]Heavy Metal Abatement & Disposal		50,000
Clean and Paint Interior:		
Contingency for Touch-Up of Shell and Floor due to Roof Access		50,000
Contingency for Roof Member Cleaning and Recoating		350,000
Completely Cleaning and Recoating Entire Interior		850,000
Contingency for Repairs to Roof Support Structure		20,000
Cathodic Protection System		12,000
Foundation Repair		2,000
Relocate Overflow Pipe	$ 8,000	
Remove Interior Ladder	2,000	
Replace Interior Ladder and Install Safe-Climbing Device	8,000	
Replace Exterior Ladder and Safe-Climbing Device	6,000	
Replace Vandal Deterrent	2,000	
Install Additional Shell Manhole	8,000	
Modify Existing Roof Manhole	2,000	
Install Roof Safety Railing	6,000	
Install Clog-Resistant Vents (3)	24,000	
Existing Vent Modifications	5,000	
Replace Door Sheet	8,000	
Isolate Lead Joint	3,000	
Contingency Items	10,000	12,000

Estimates are believed to be a high average of bids that would be received in 2017.

[1] The replacement estimate includes costs associated with new tank fabrication and erection, foundation, painting, and engineering. The budget estimate given does not include costs associated with tank demolition, site acquisition, and distribution interruptions.

[2] Heavy metal abatement is included in the economic factors; however, the hazardous disposal will not be required unless the abrasive residue is determined to be hazardous.

The following economic factors include only those work items that the Engineer believes to be the minimum to properly maintain this tank from an operational standpoint. Other items related to safety and risk management should be evaluated by the Owner.

Item	Cost
Clean and Paint Exterior:	
SP 6, Complete Clean, Epoxy/Polyurethane System	$ 400,000
Containment	100,000
Heavy Metal Abatement & Disposal	50,000
Clean and Paint Interior:	
Contingency for Touch-Up of Shell and Floor due to Roof Access	50,000
Contingency for Roof Member Cleaning and Recoating	350,000
Contingency for Repairs to Roof Support Structure	20,000
Cathodic Protection System	12,000
Foundation Repair	2,000
Relocate Overflow Pipe	8,000
Remove Interior Ladder	2,000
Replace Exterior Ladder and Safe-Climbing Device	6,000
Replace Vandal Deterrent	2,000
Install Additional Shell Manhole	8,000
Modify Existing Roof Manhole	2,000
Install Roof Safety Railing	6,000
Install Clog-Resistant Vents (3)	24,000
Replace Door Sheet	8,000
Isolate Lead Joint	3,000
Contingency Items	12,000
Total of Engineer's Recommendations	**$ 1,065,000**

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 Winchester owns and operates a 3,000,000 gallon ground storage tank in Winchester, Virginia. The coating on the exterior was in very poor condition with widespread areas of peeled coating and corrosion noted. The exterior should be repainted within the next 2 to 3 years. The interior coating was in good overall condition. 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 the installation and proper maintenance of a new ice-resistant cathodic protection system with long-life anodes.

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 NACE, ANSI/NSF Standard 61, the manufacturer's recommendation, AWWA D100 and AWWA D102 (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 3 to 5 years.

Time Frame: If the work is not performed within the next 18 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 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,

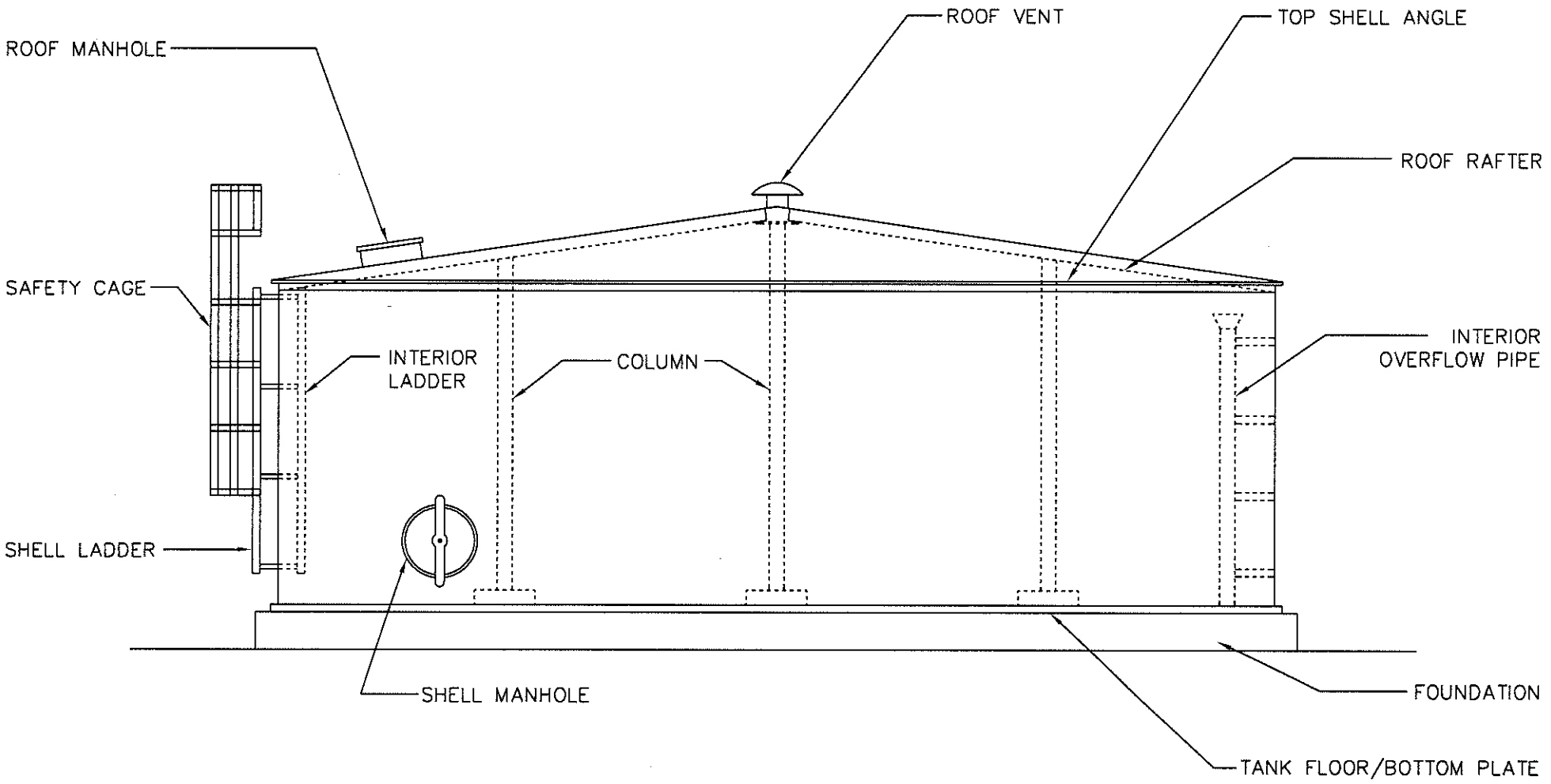
Tank Industry Consultants

Jennifer Coon, CSP, CHMM, CET

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

COMMONWEALTH OF VIRGINIA
GREGORY R. STEIN
Lic. No. 023683
PROFESSIONAL ENGINEER

GROUND STORAGE TANK



NOMENCLATURE

Classification of Adhesion Test Results

Method A – X Cut Tape Test Approx. 1.5 in. long cuts at 30 deg. to 45 deg. apart.	Surface	Classification
No peeling or removal.		5
Trace peeling or removal along incisions.		4
Jagged 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 Tape 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 coating are detached 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 coating has flaked along the edges and on parts 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

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Indianapolis, Indiana 46214

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- CERTIFICATE OF ANALYSIS -

Disp. Code: E I

Report Date: *28-Aug-17 02:35 PM*

Client ID: TANK_INDUST

Tank Industry Consultants
7740 West New York Street
Indianapolis, Indiana 46214

Phone: (317) 271-3100
Attn: Bruce Hobbs
FAX: (317) 271-3300

Our Lab # 17013665-001
Your Sample ID: Int.
Sample Composition: Grab

Your Project # 17.125.E954.005
Collection Date: 08/15/17
Your Project Name: **Paint Samples**
Collected By: Client
Sample Type: Paint Chips
Receipt Date: 08/23/17 13:00

Total Metals, ICP-AES

Analytical Method	Prep Method	Prep Date	By
SW846 6010B	SW846 3050B	8/28/2017	spotts

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Cadmium, Cd	< 25.0	mg/kg		25.0	7440-43-9	08/28/17 10:18	rmccoskey
Chromium, Cr	< 250	mg/kg		250	7440-47-3	08/28/17 10:18	rmccoskey
Lead, Pb	< 250	mg/kg		250	7439-92-1	08/28/17 10:18	rmccoskey

Our Lab # 17013665-002
Your Sample ID: Ext.
Sample Composition: Grab

Your Project # 17.125.E954.005
Collection Date: 08/15/17
Your Project Name: **Paint Samples**
Collected By: Client
Sample Type: Paint Chips
Receipt Date: 08/23/17 13:00

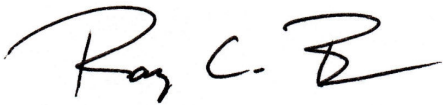
Total Metals, ICP-AES

Analytical Method	Prep Method	Prep Date	By
SW846 6010B	SW846 3050B	8/28/2017	spotts

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Cadmium, Cd	< 25.0	mg/kg		25.0	7440-43-9	08/28/17 10:18	rmccoskey
Chromium, Cr	4230	mg/kg		250	7440-47-3	08/28/17 10:18	rmccoskey
Lead, Pb	134000	mg/kg		4000	7439-92-1	08/28/17 10:18	rmccoskey

ESG Laboratories
5940 WEST RAYMOND STREET
INDIANAPOLIS, INDIANA 46241

PHONE (317) 290-1471
FAX (317) 290-1670
www.ESGLaboratories.com



8/28/2017

Lab Manager **Date**

Lab # 17013665-002 **Sample ID:** Ext. *Page 2 of 2*

ESG Laboratories
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1. Tank overview.

2. Site access.

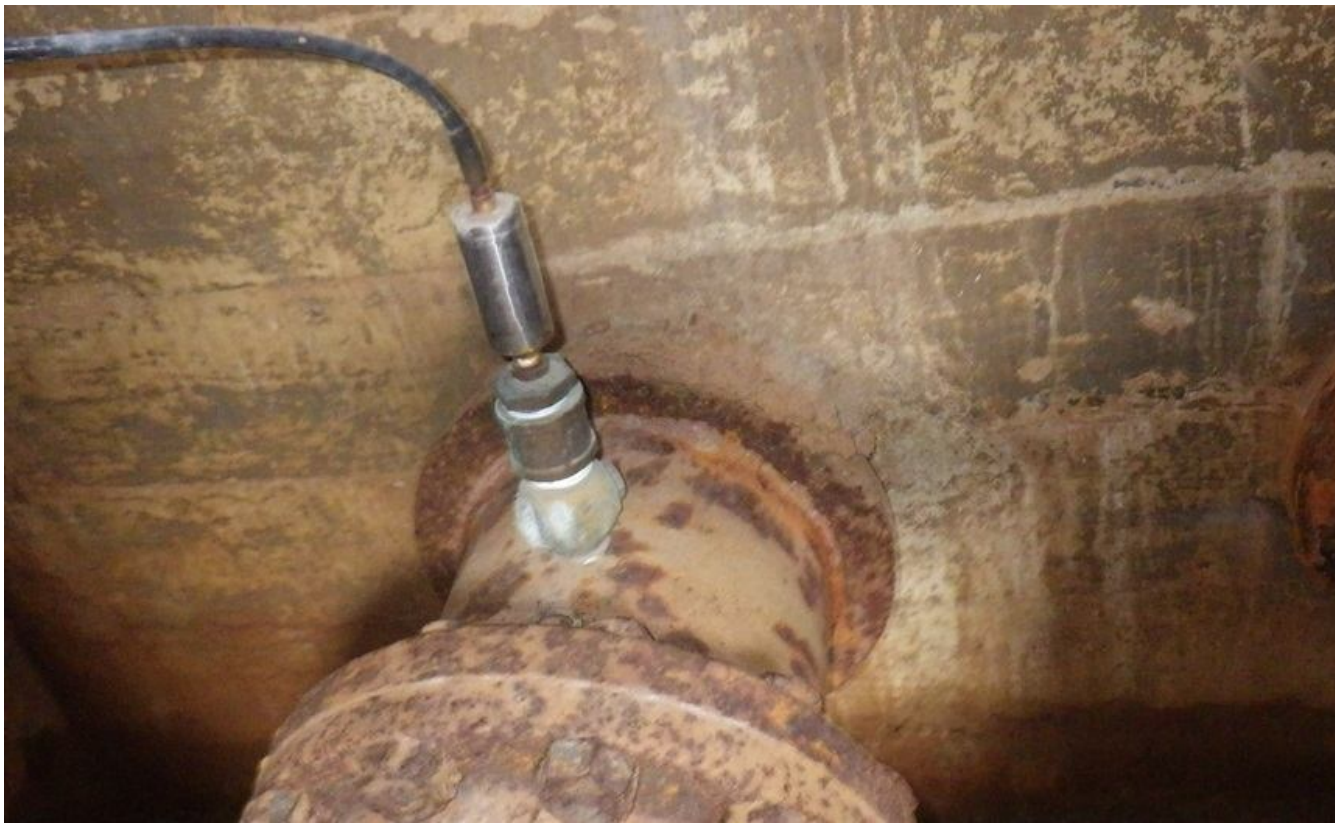
3. View from roof.

4. View from roof.

5. Valve vault.

6. Valve vault access.

7. Valve vault piping.



8. Valve vault piping.

9. Valve vault piping bolts and nuts. Note significant layering corrosion.

10. Valve vault rungs.

11. Pieces of peeled coating on ground.

12. Cracking and spalling in foundation.

13. Foundation and bottom plate at void in sealant.

14. Peeled sealant on foundation.

15. Corrosion on bottom plate.

16. Foundation.

17. Exterior shell.

18. Exterior shell. Note door sheet.

19. Coating failure on exterior shell.

20. Exterior shell. Note unused bracket.

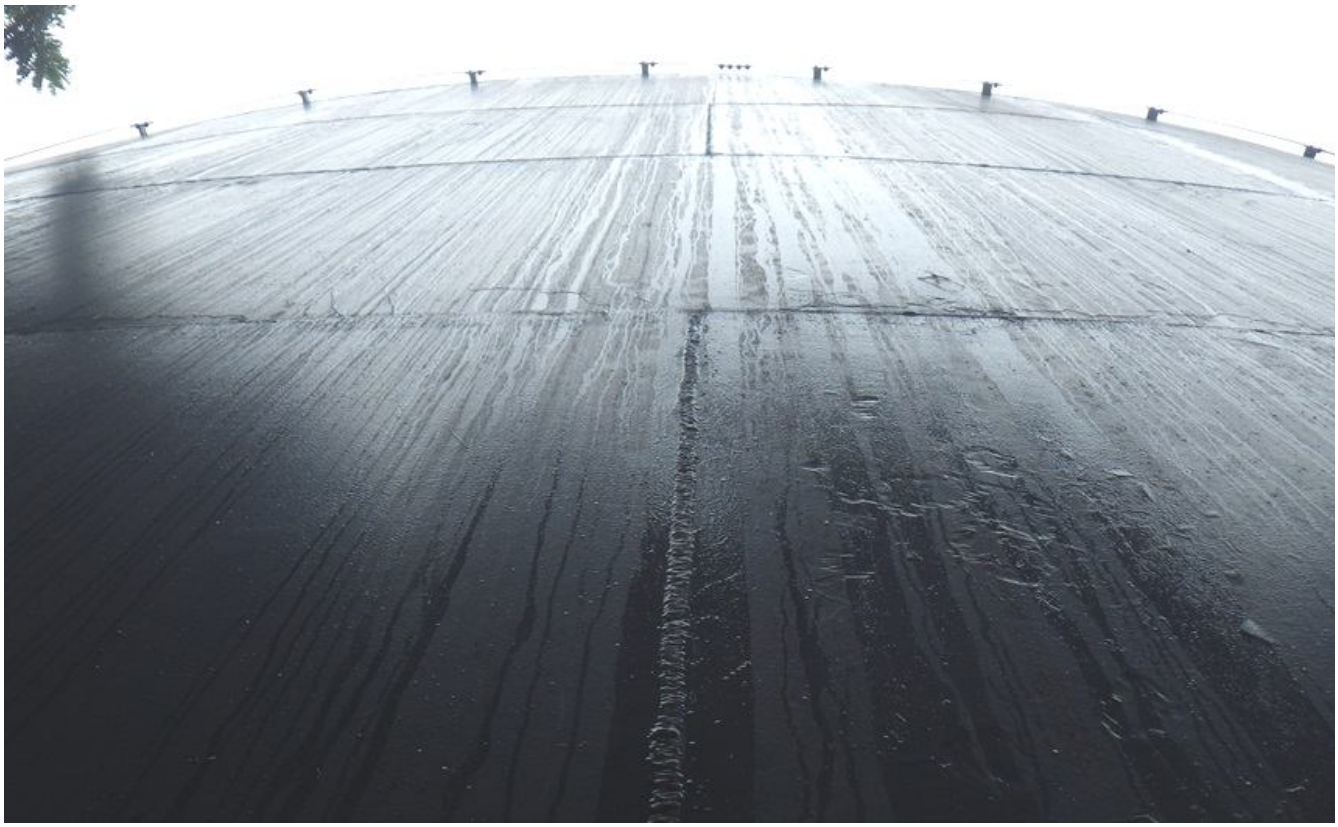
21. Peeled coating and corrosion on shell.

22. Unused brackets on exterior shell.

23. Exterior shell.

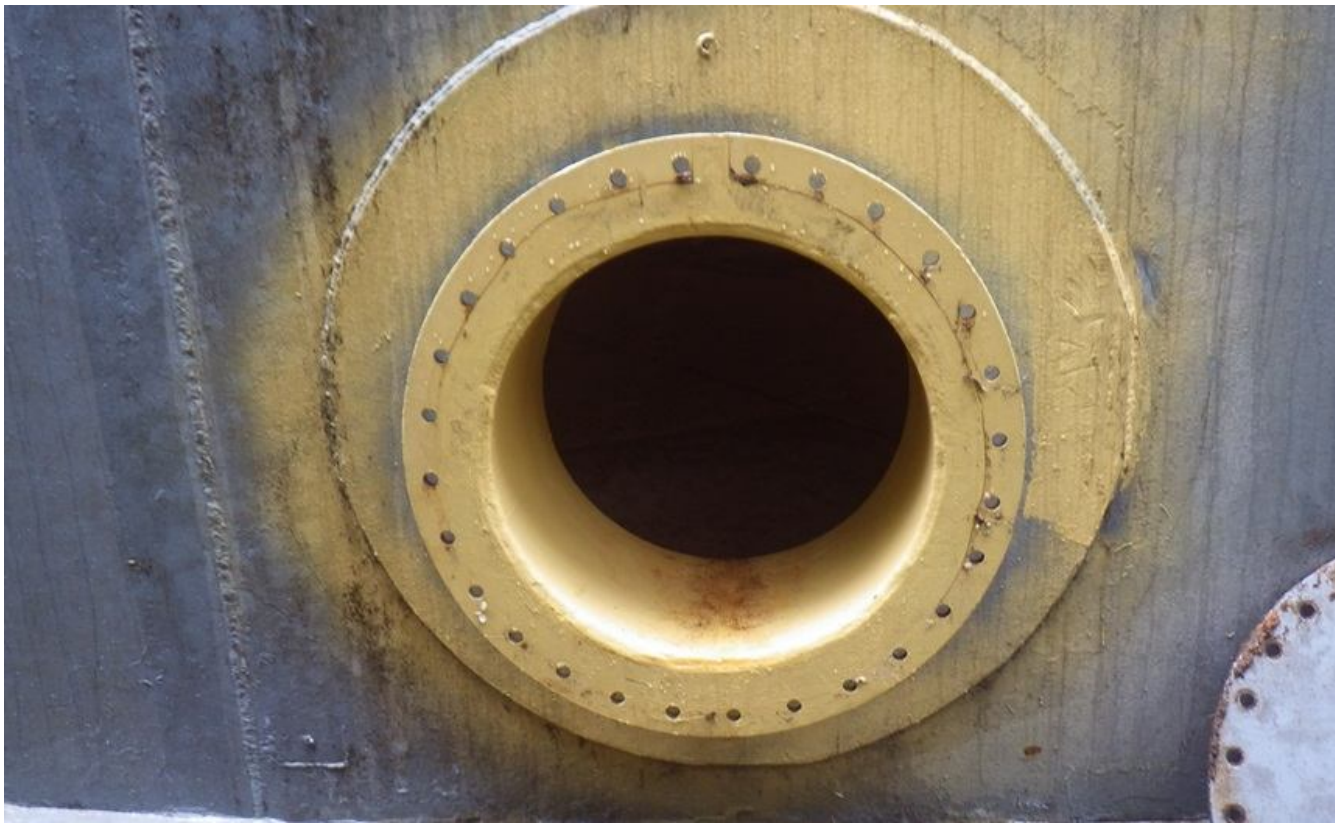
24. Peeled coating on shell.

25. Exterior shell.



26. Exterior shell. Note proximity of tree branches.

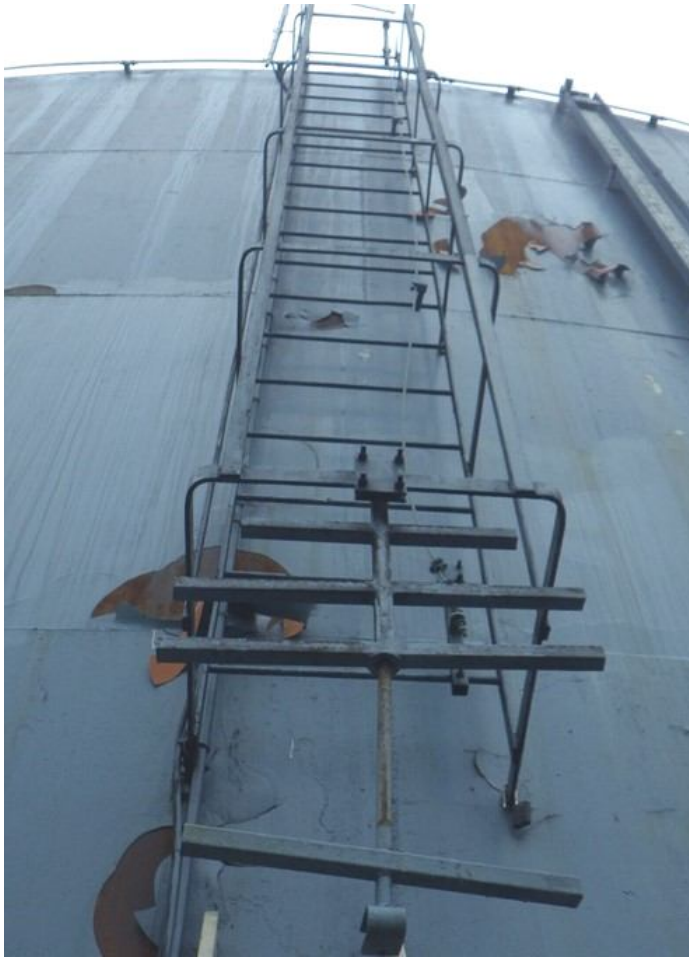
27. South manhole.



28. North manhole.

29. Target gage.

30. Target gage brackets.



31. Exterior shell ladder, safety cage, and safe-climbing device.

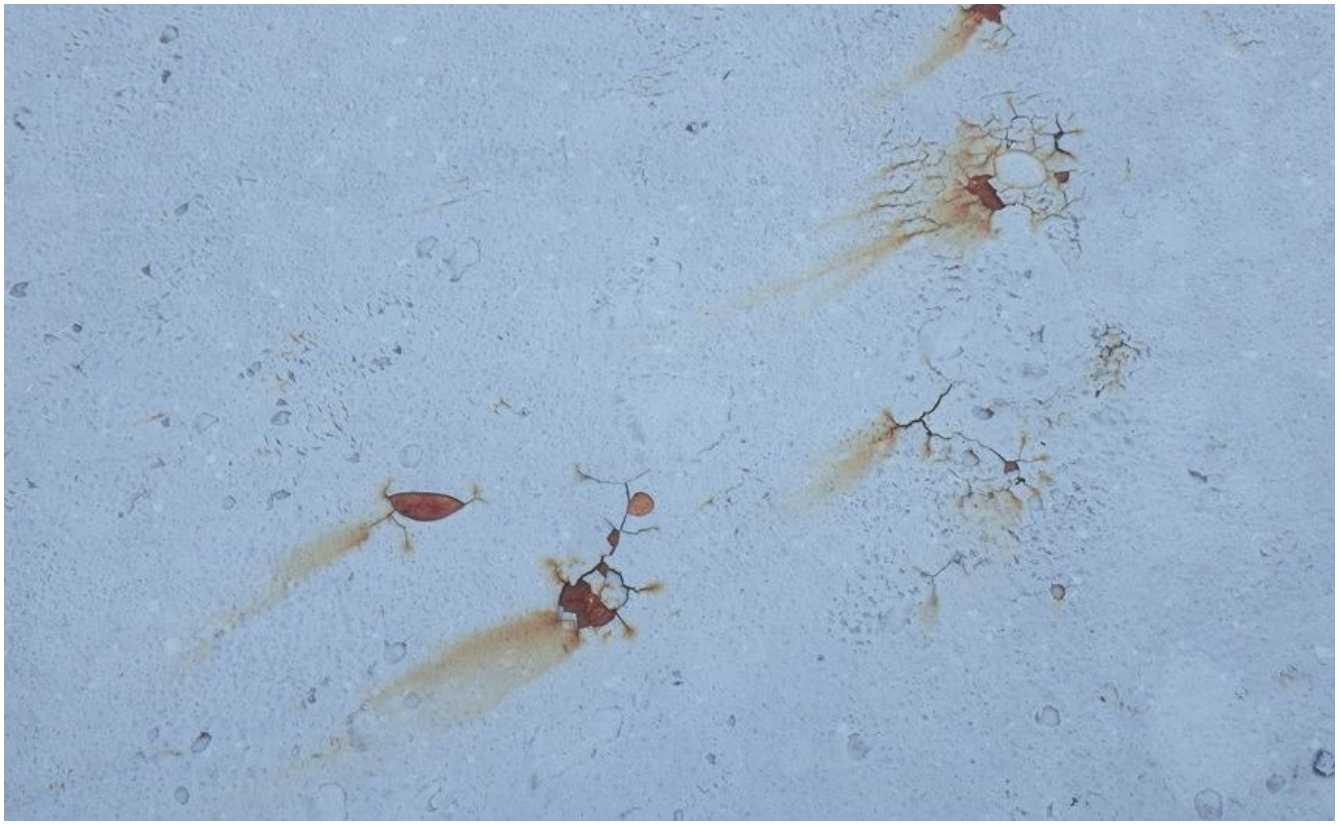
32. Exterior shell ladder, safety cage, and safe-climbing device. Note offset safe-climbing device.

33. Exterior shell rail.

34. Exterior shell rail and target gage.

35. Coating failure on exterior shell.

36. Exterior shell ladder terminals.



37. Exterior roof coating failures.

38. Evidence of water ponding on roof.

39. Evidence of water ponding on roof.

40. Exterior roof coating failures.

41. Exterior roof coating failures.

42. Exterior roof.

43. Target gage equipment on roof.

44. Mixing system solar panel.

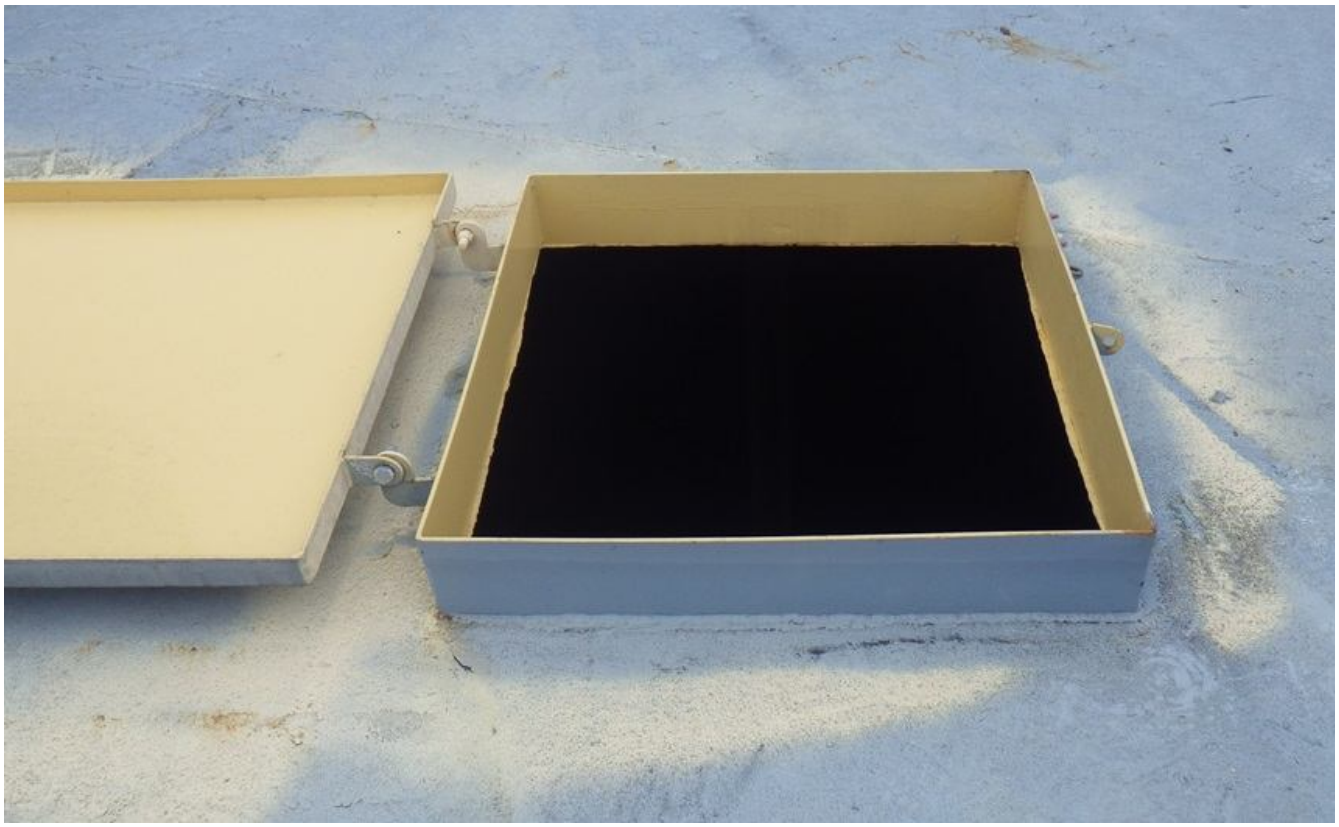
45. Roof vent.

46. Hole in roof vent cover.

47. Conduit on roof.

48. Sensor penetration on roof.

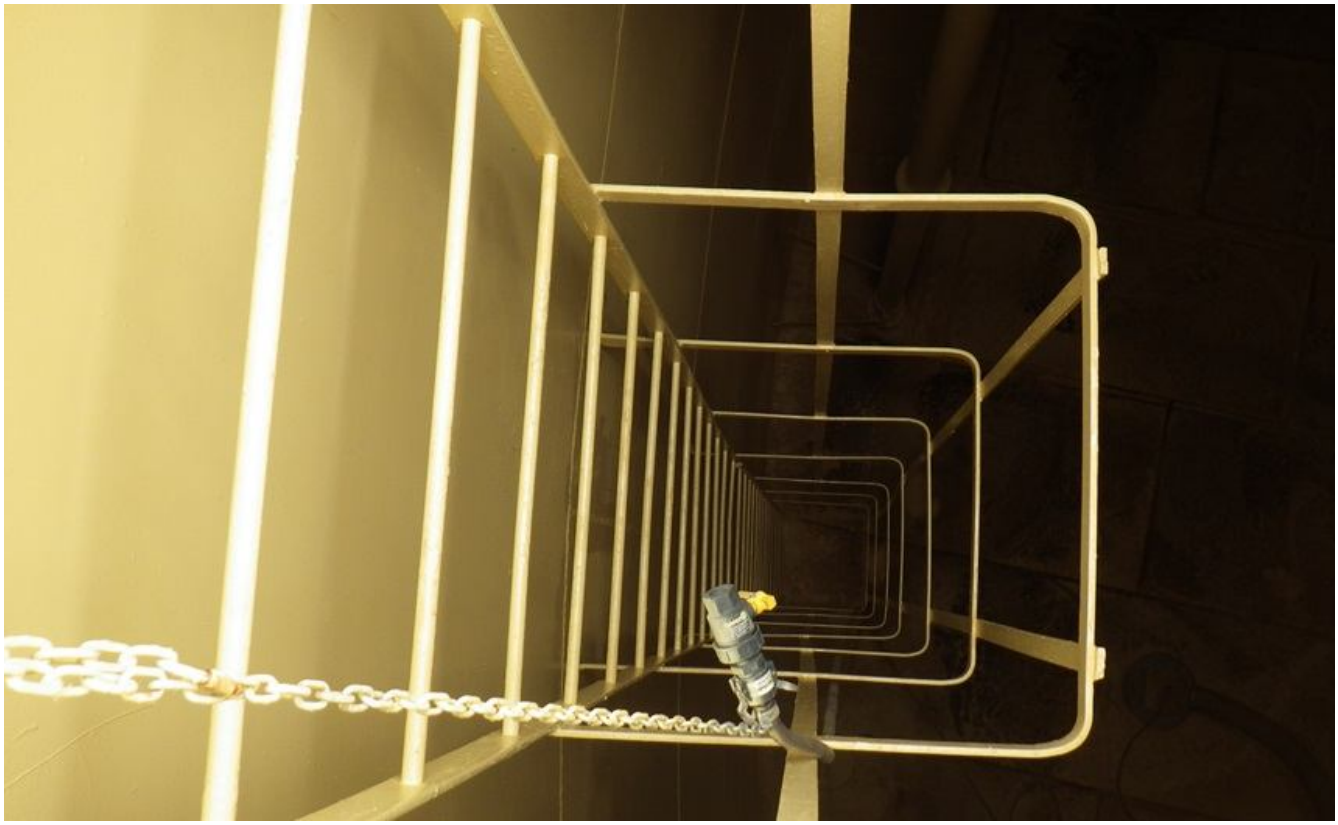
49. Roof vent.



50. Roof manhole.

51. Roof manhole.

52. Open roof manhole with interior ladder.



53. Interior ladder.

54. Interior roof structure.

55. Interior roof structure.

56. Roof support structure.

57. Circumferential girders.

58. Rafter end.

59. Interior roof.

60. Roof rafters and purlins.

61. Interior roof.

62. Sensor penetrating roof.

63. Rafter and attachment clip to shell.

64. Rafter and attachment clip to shell. Note significant previous metal loss and missing nut.

65. Rust between roof and rafter.

66. Rust between roof and top shell angle.

67. Interior floor and columns.

68. Interior container overview.

69. Interior container.

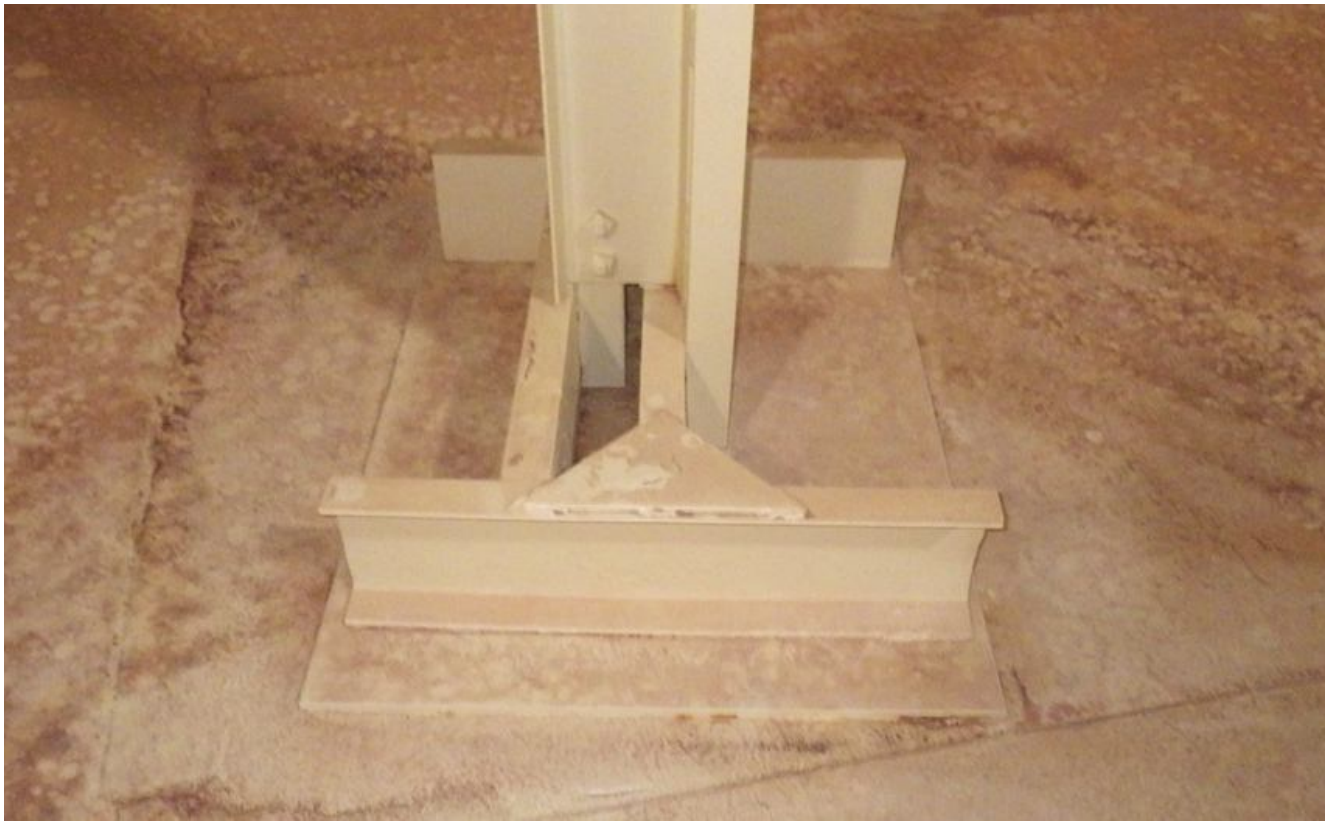
70. Interior container.

71. Interior ladder, safety cage, inlet pipe and overflow pipe.

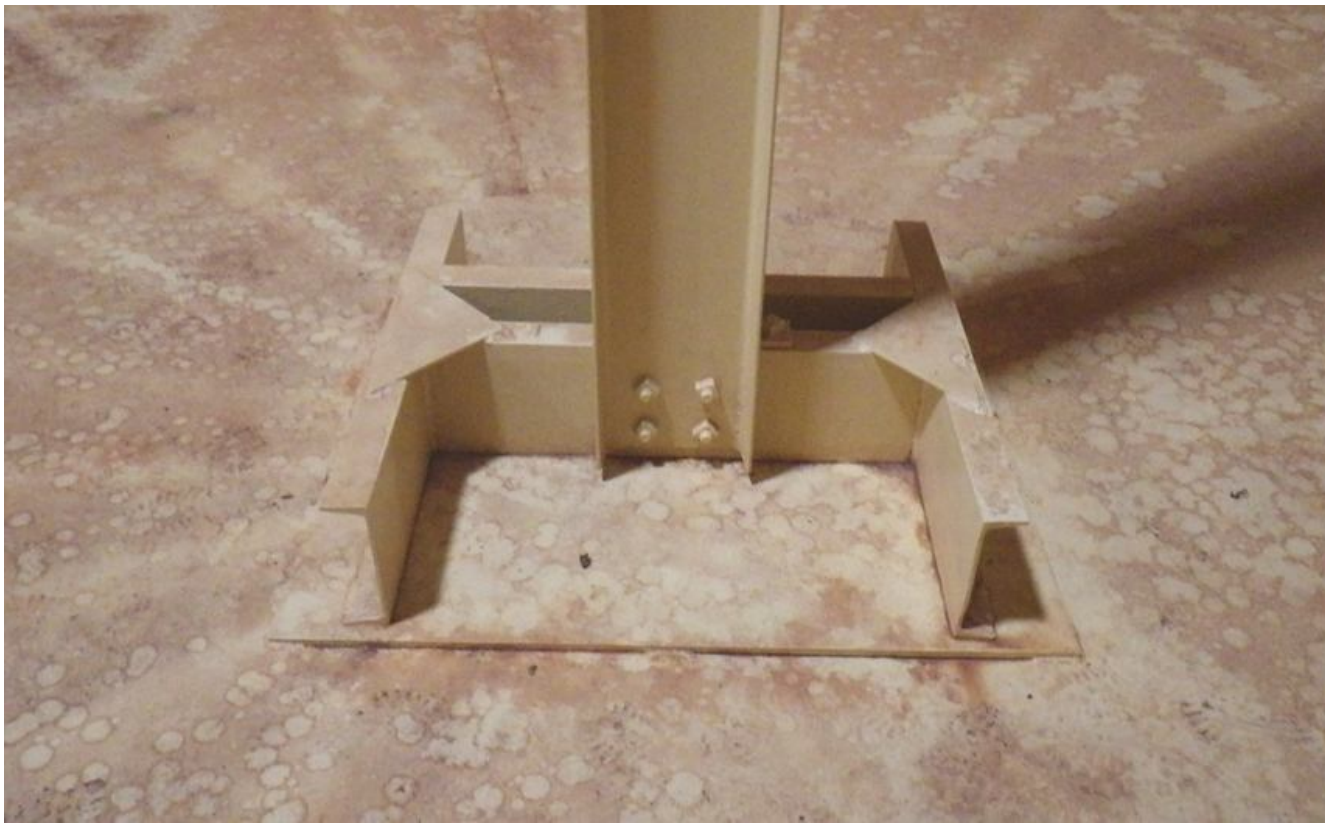
72. Columns.

73. Roof support center column.

74. Roof support column.



75. Roof support column base.



76. Roof support column base.

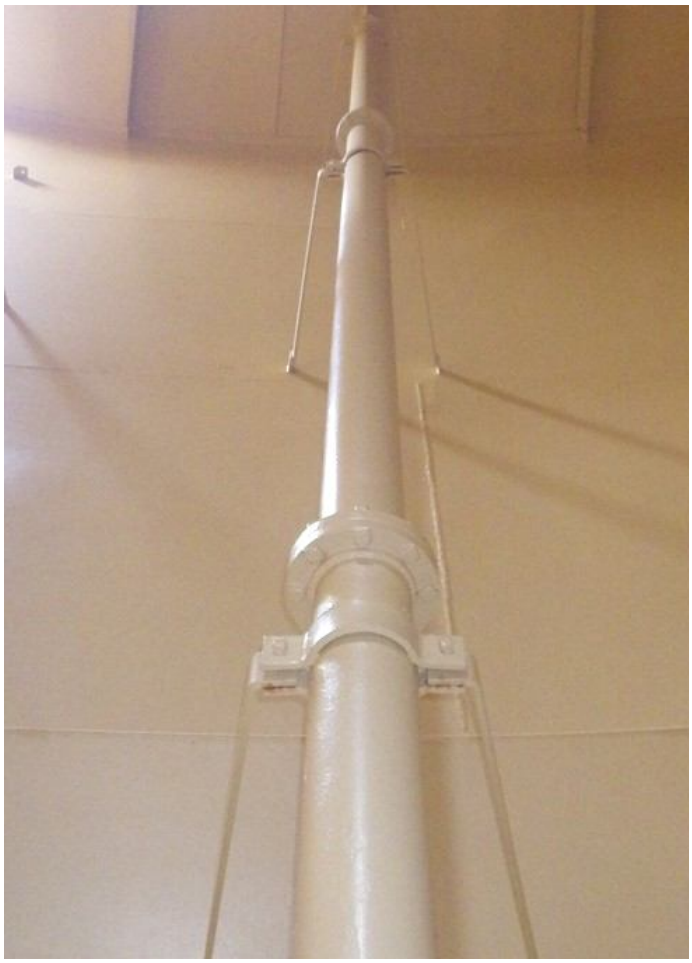
77. Roof support column base.

78. Interior shell.

79. Floor opening. Note reinforcing floor plates.

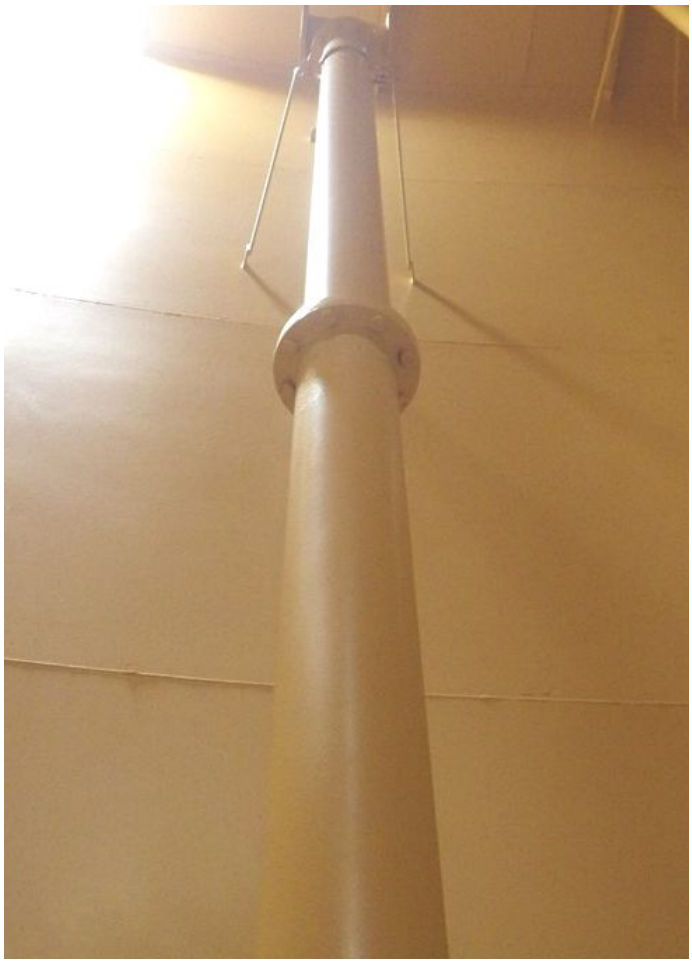
80. Overflow pipe floor penetration.

81. Inlet pipe floor penetration.

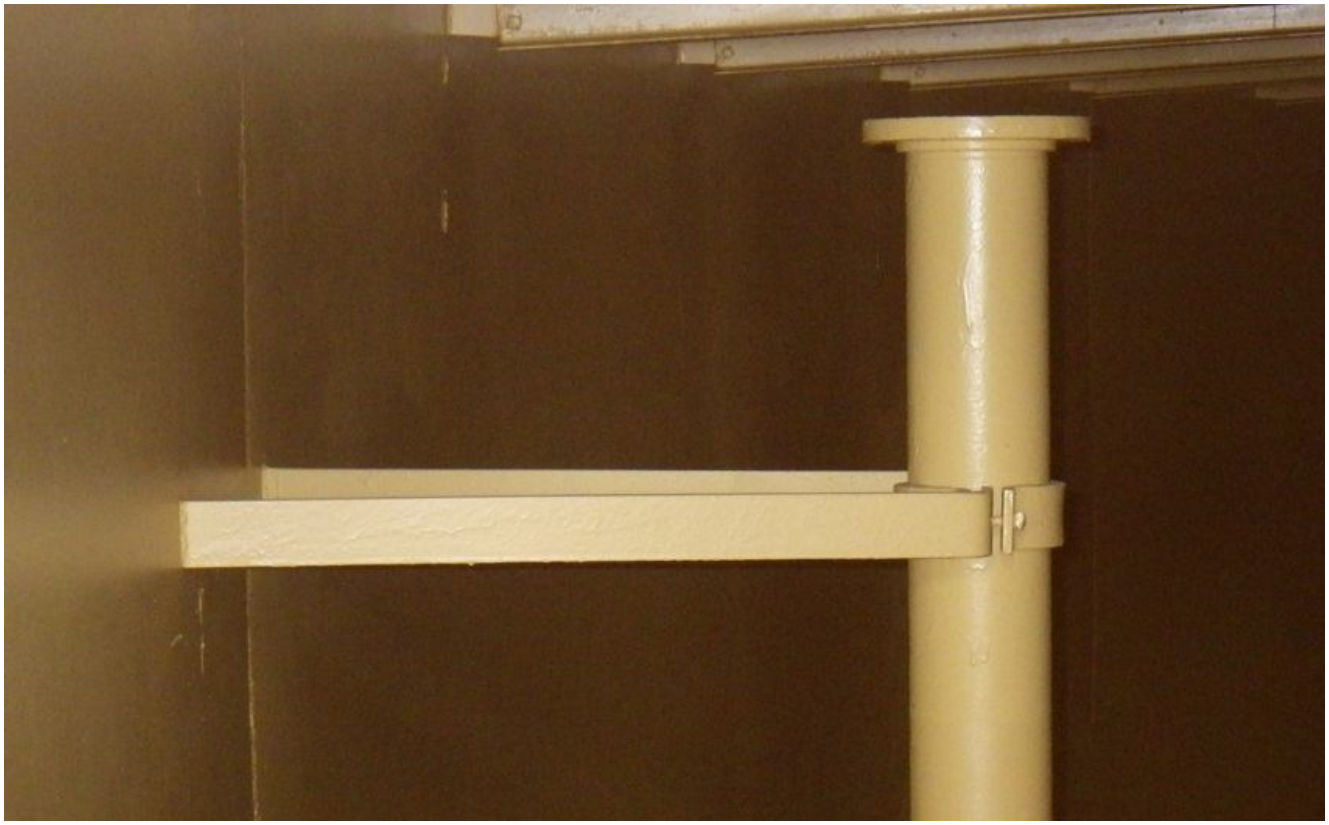


82. Overflow pipe along shell.

83. Inlet pipe discharge.



84. Inlet pipe.



85. Overflow pipe and brackets.

86. Outlet pipe opening.

87. Target gage float.

88. Water mixing system.