Managing and Maintaining Your Elevated Water Storage Assets

New Tank Design and Construction and Existing Tank Condition Assessment

Presented By: AECOM | Nathan Ward

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Agenda

- Introduction
- Safety Moment
- New Tank Design and Construction
- Tank Coating Systems
- Existing Tank Condition Assessment
- Wrap-up and Questions

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Tank Design
Tank Construction
Existing Tank Assessment
Existing Tank Rehabilitation

New Tank Design And Construction

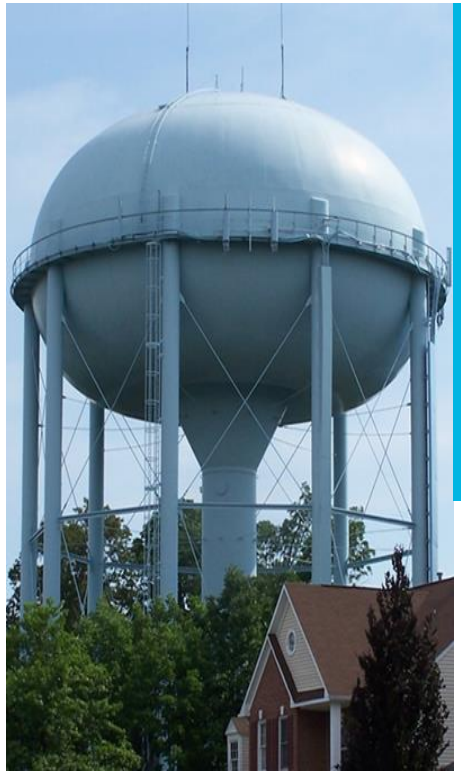
Safety Moment – Personal Protective Equipment (PPE)

- Helmet
- Gloves
- Safety Glasses
- Safety Climb
- Harness
- Steel Toe Boots
- Lanyard
- Safety Vest

New Tank Design and Construction | What Tank Style?

FOUR MAJOR STYLES OF ELEVATED TANKS

Fluted Column Tank



Multi-Column Tank

Composite Tank

Single Pedestal Spheroid Tank

MAJOR TANK MANUFACTURERS:

- Caldwell
- Landmark
- Phoenix
- CB&I (McDermott)

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New Tank Design and Construction

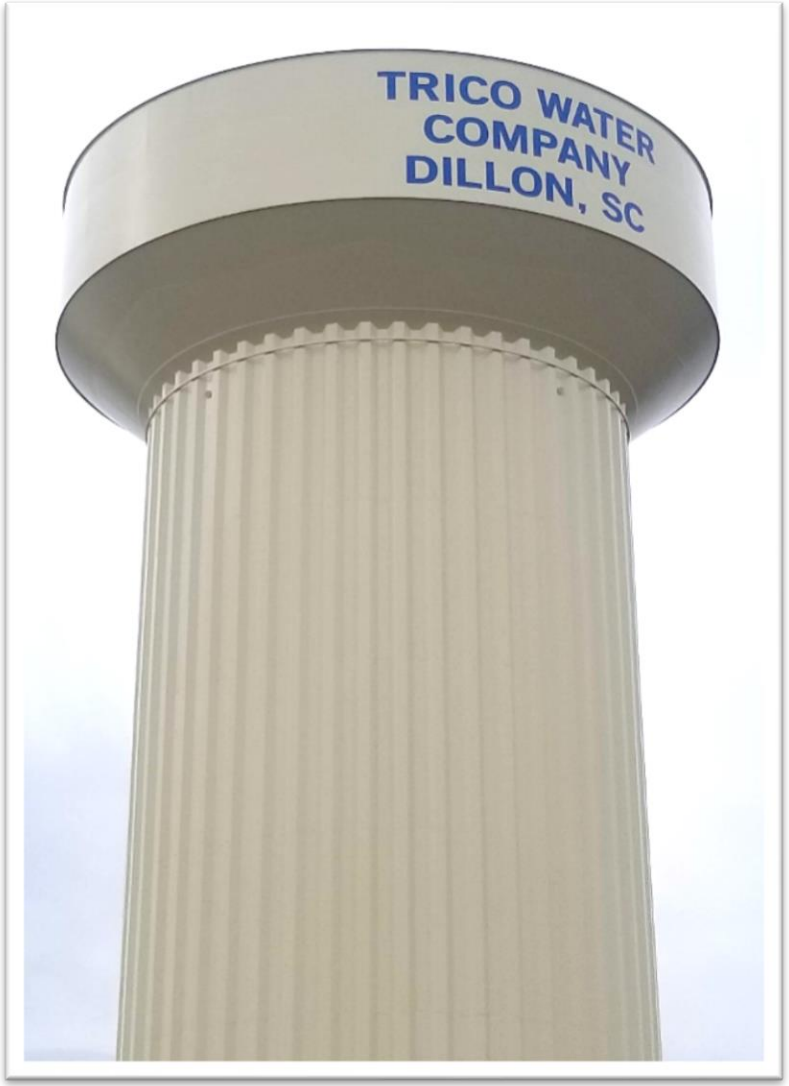
What Tank Style | Fluted Column Tank

+ PROS

- Electrical components can be stored in the interior base of the tank
- **Piping, control valves and/or booster pumps can be located in the interior base of the tank**
- **Safety:** Interior ladders and controlled access
- Steel shaft can be painted to match tank
- More rigid than composite tanks (beneficial in seismic zones)
- Easier design for a multi-use facility (i.e. large diameter steel shaft)
- Can **co-locate an alternate use** in interior of base of tank

- CONS

- More steel structure to paint = **more maintenance costs**



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New Tank Design and Construction

What Tank Style | Multi-Column Tank

+ PROS

- **Cost competitive in smaller sizes** (< 0.75 MG)
- "Classic" style
- Can be preferred for areas of high wind and/or seismic activity

- CONS

- Typically **more expensive** in larger sizes (> 1.0 MG).
- Not all manufacturers will build in the larger sizes (> 2.0 MG).
- More maintenance costs (more steel = more paint).
- **More difficult maintenance** (i.e. sandblasting and painting steel (rods, brackets, struts, etc.)
- Electrical components remain outside
- Exterior ladders and access

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New Tank Design and Construction

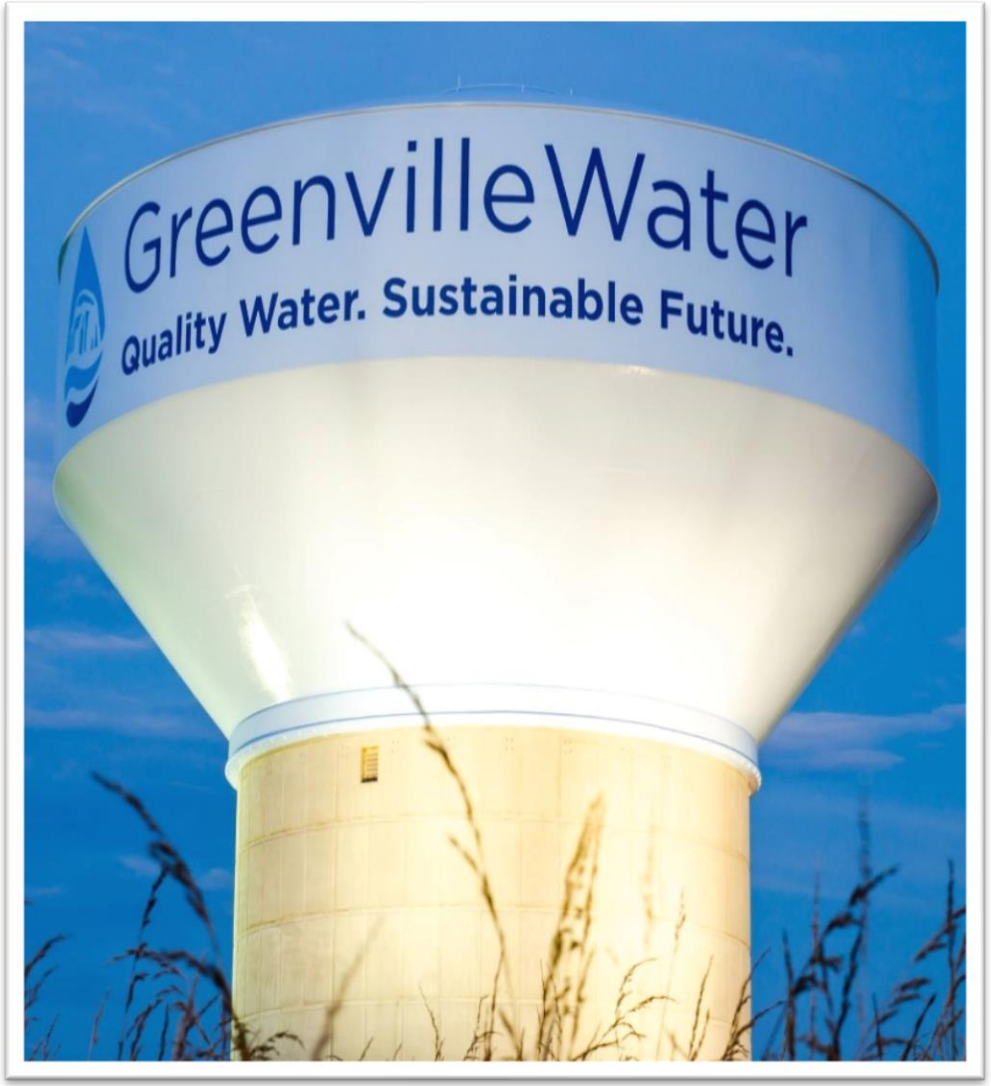
What Tank Style | Composite Tank

+ PROS

- Less steel structure to paint = less maintenance costs
- Approximately **15-20% maintenance savings**
- Larger sizes (> 1.0 MG) are typically more cost competitive
- Electrical components can be stored in the interior base of the tank.
- **Piping, control valves and/or booster pumps can be located in the interior base of the tank**
- **Safety:** Interior ladders and controlled access.
- Can **co-locate an alternate use** in interior of base of tank.

- CONS

- "Newest" tank style (First composite tanks were built in the late 70's).
- Potential long term concrete issues?



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New Tank Design and Construction

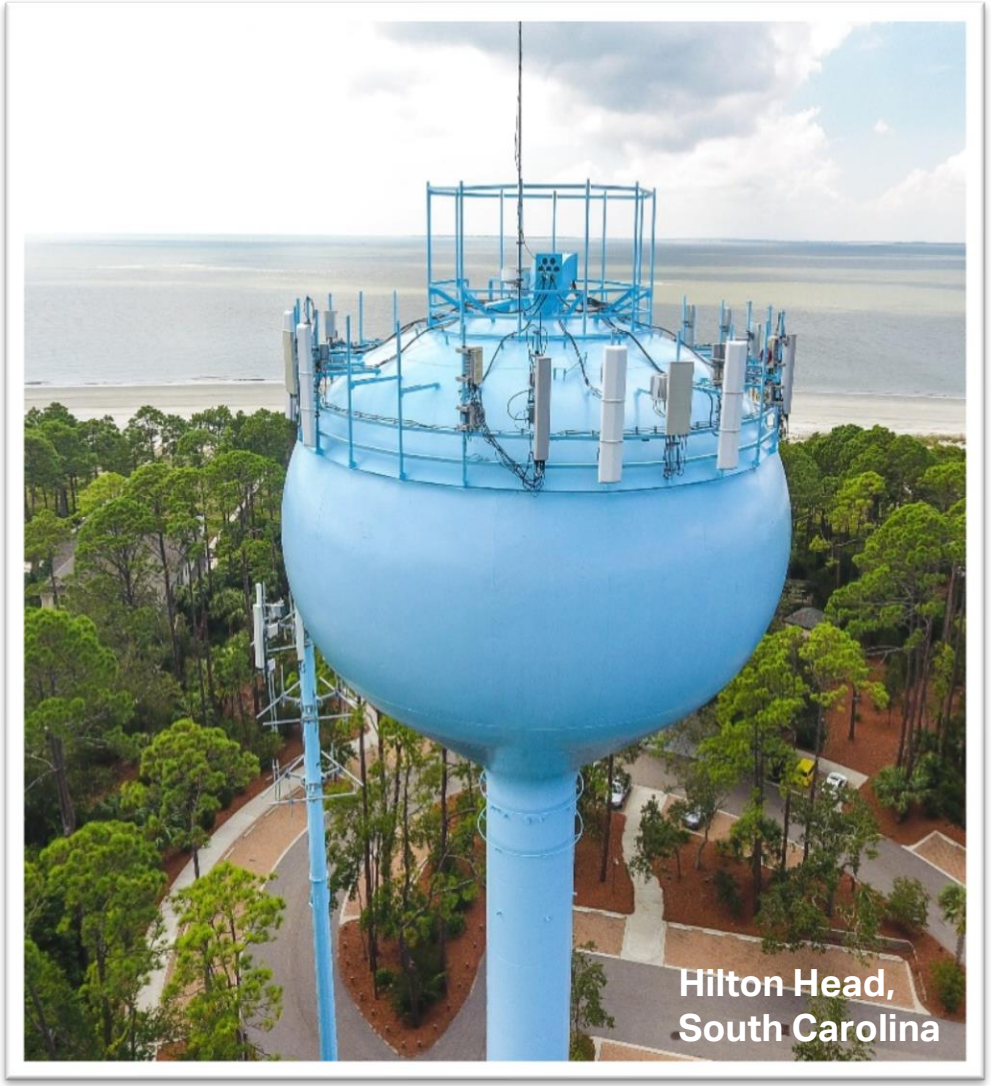
What Tank Style | Single Pedestal Spheroid Tank

+ PROS

- **"Best looking" tank** (in many minds)
- Electrical components can be stored in the interior base of the tank
- Piping, control valves and/or booster pumps can be located in the interior base of the tank
- **Safety** - Interior ladders and controlled access
- Smallest footprint of the 4 tank styles

- CONS

- Typically the **most expensive** in all sizes compared to other tank styles
- **Most manufacturers will not build** in the larger sizes (> 2.0 MG)



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New Tank Design and Construction Cost Comparison

Tank Style	Base Estimate (1.5 MG, 195 FT to OVF)	Base Estimate (2.0 MG, 155 FT to OVF)	Base Estimate (3.0 MG, 165 FT to OVF)
Multi-Column	$3,800,000	$4,800,000	$5,500,000
Single Pedestal Spheroid Tank	$4,800,000	$5,500,000	$6,900,000
Fluted Column Tank	$3,900,000	$4,400,000	$5,900,000
Composite Tank	**$3,300,000**	**$3,900,000**	**$4,950,000**

How to Approach the Detailed Design?

Important Design Considerations | Site

Picking the Site!

- Site location (**site elevation**, parcel size, zoning, FAA, etc.)
- Site layout (constructability, access, etc.)
- Stormwater
- Overflow/drain discharge location
- **Transmission main connection**
- Neighbor concerns (NIMBY)
- Public meetings

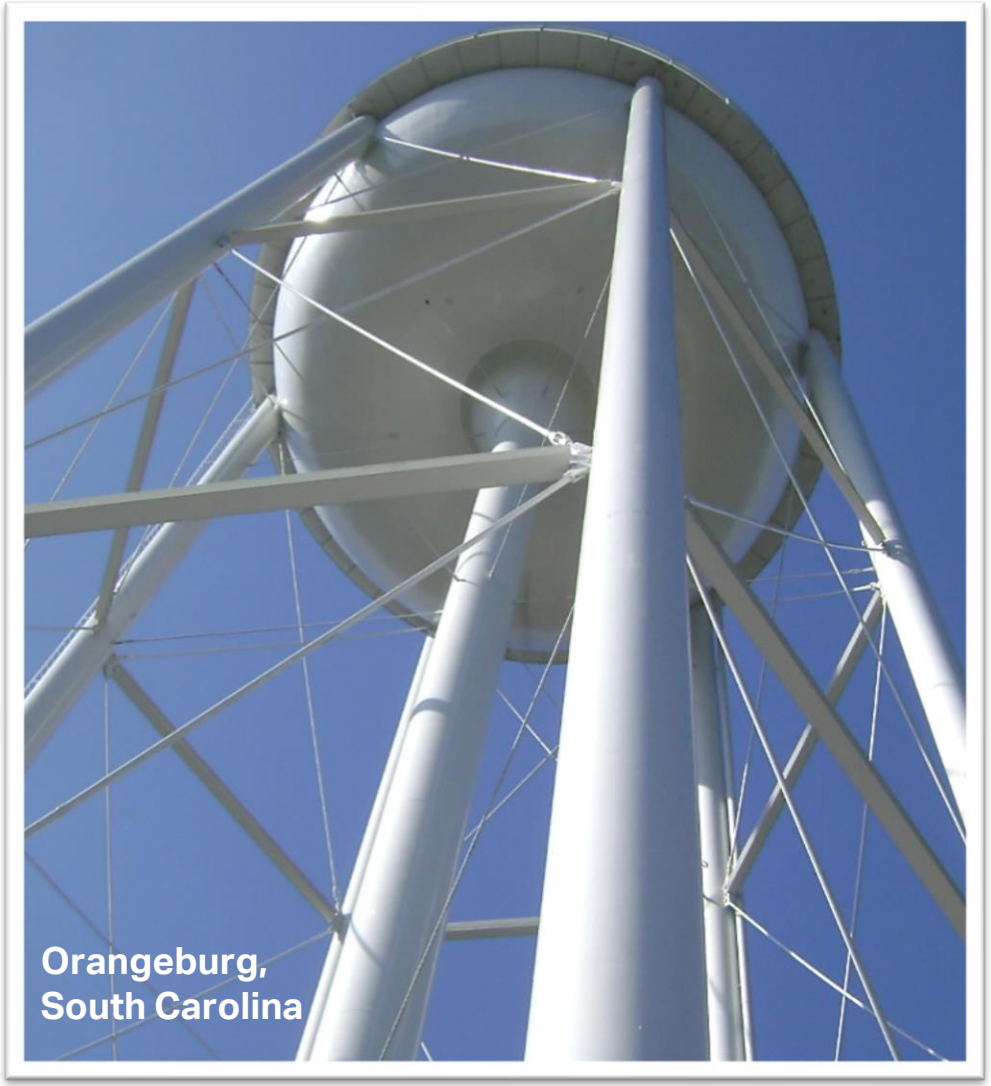
Hydraulic Modeling

- Tank height and size
- Water age/tank turnover
- Sizing the piping to the tank

Geotech Work

- Can the **soils handle the loads** of the tank?
- Foundation design requirements

Survey and Title Search



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Important Design Considerations | Site

- **Site access**
- Zoning and setback requirements
- Topographic/grading considerations
- **Stormwater runoff**
- **Tank Draining**
- Erosion control
- **DOT encroachment permits**
- Stormwater permits
- Landscaping requirements

Important Design Considerations | Site

Foundation Design

Concrete spread footing

Piles (steel or auger cast piles)

Important Design Considerations | Water

Control Valves

Important Design Considerations | Water

Tank Mixing

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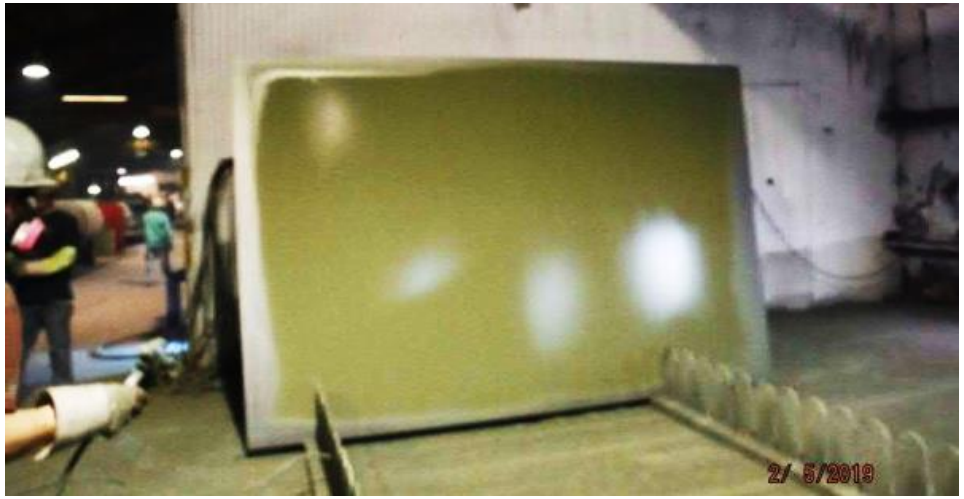
Important Design Considerations | Water

Separate Inlet/Outlet Pipes

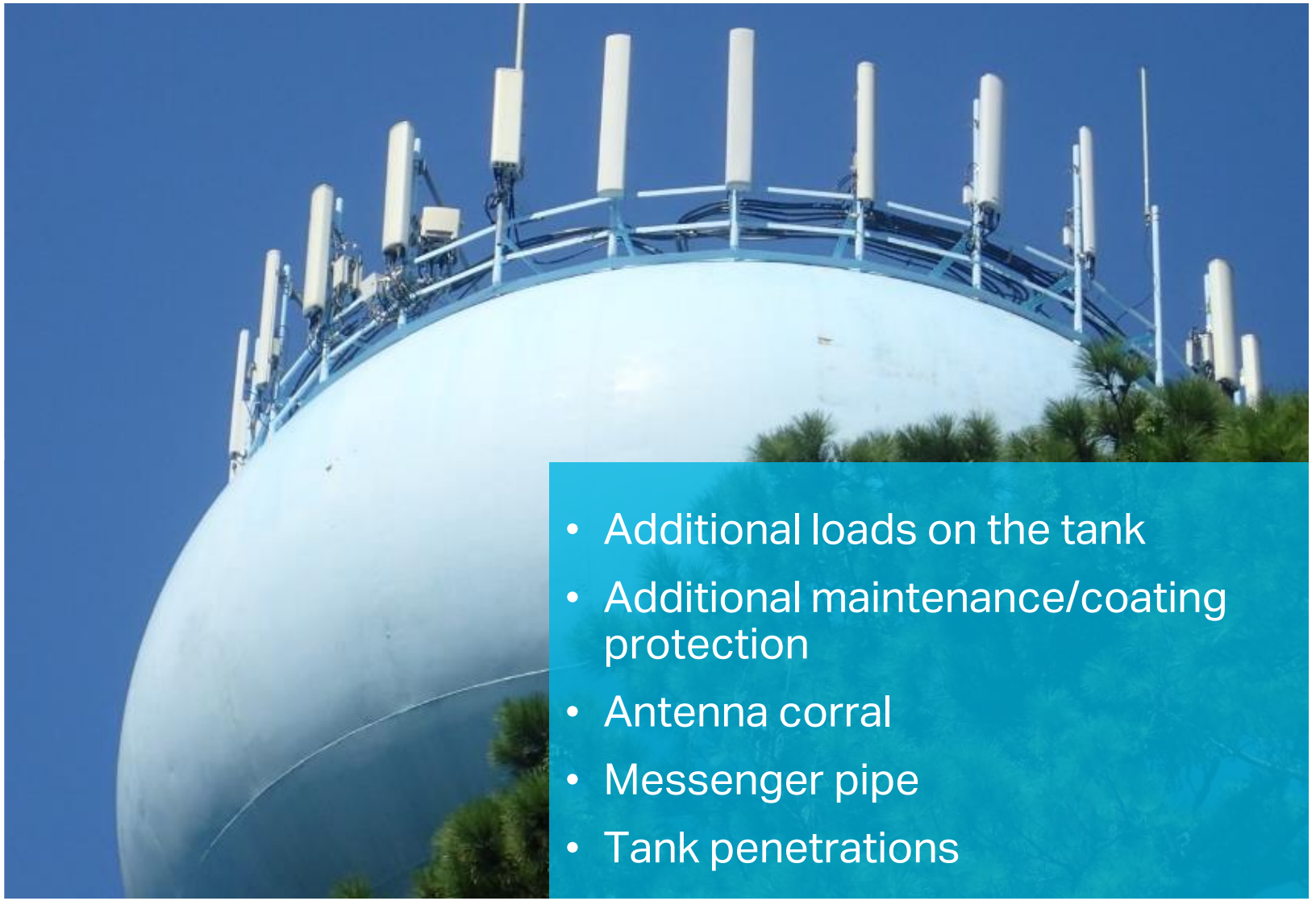
Planning for Future Pumps

Important Design Considerations | **Specifications**

- **Design parameters** (snow loads, wind loads, earthquake, etc.)
- AWWA D100, "Welded Carbon Steel Tanks for Water Storage“
- Minimum steel thickness (i.e. 1/4”)
- **Corrosion allowance (1/16”)**
- **Seal welding**
- **Factory site visit**
- Dissimilar metals
- X-ray testing
- Weld smoothness Condition “D” (ground smooth and blended) of NACE Standard RP0178.
- **NACE Inspectors**



Important Design Considerations | Antennas



- Additional loads on the tank
- Additional maintenance/coating protection
- Antenna corral
- Messenger pipe
- Tank penetrations

Important Design Considerations | Miscellaneous

- Electrical
- SCADA
- FAA lights
- Spot lights
- Pumps, valves, etc.
- Future maintenance

Important Design Considerations | Alternative Use?

- Fire station
- Office space
- Booster pump station
- Maintenance shop
- Storage

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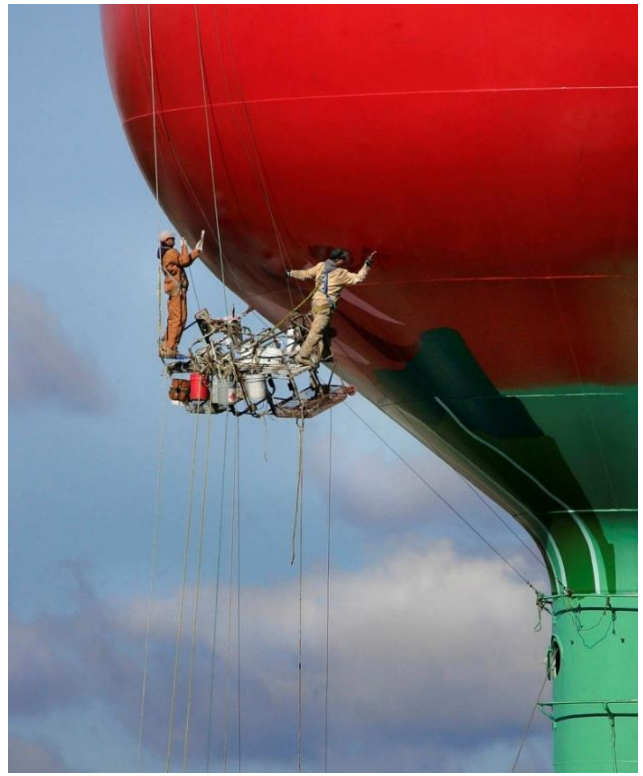
Important Design Considerations | Artwork and Logos



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Tank Coating Systems

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Tank Design
Tank Construction
Existing Tank Assessment
Existing Tank Rehabilitation

Important Design Considerations | Coating Systems

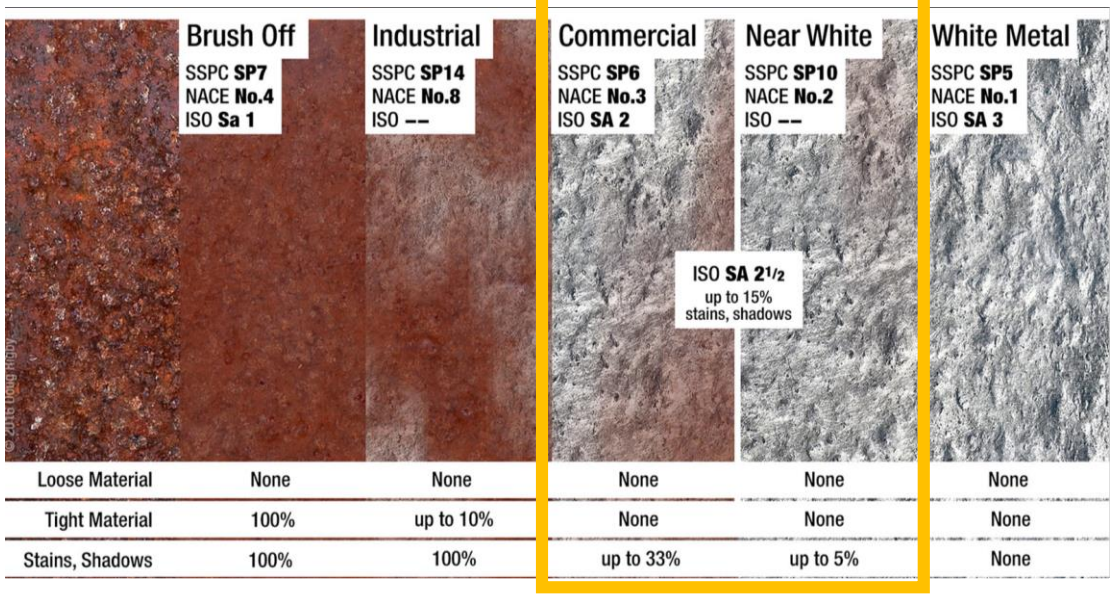
NSF 600 Requirements

- Effective 1/1/2023
- Not Retroactive
- **Tank interior coating specifications will need to be modified for new tank projects**

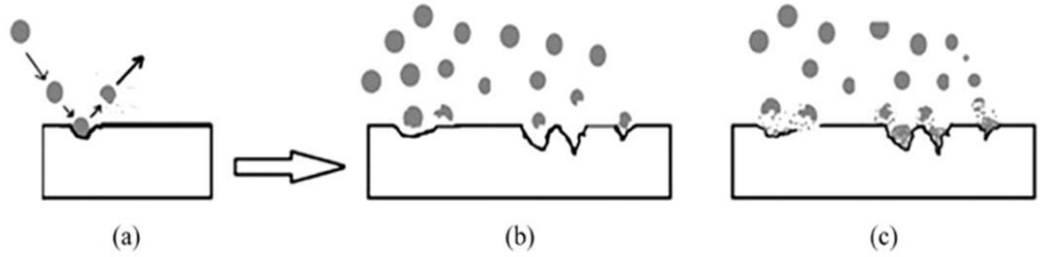
		Previous Criteria			New NSF 61/600 Criteria		
Substance	CASRN	MCL/MAC or TAC (mg/L)	SPAC (mg/L)	STEL (mg/L)	MCL/MAC or TAC (mg/L)	SPAC (mg/L)	STEL (mg/L)
Xylenes	all isomers	10	1	--	0.09 (total)	0.009 (total)	--
Ethylbenzene	100-41-4	0.7	0.07	--	0.14	0.014	--
Toluene	108-88-3	1	0.1	--	0.06	0.006	--

Source: Tnemec

Important Design Considerations | Surface Prep



Loose Material	None	None	None	None	None
Tight Material	100%	up to 10%	None	None	None
Stains, Shadows	100%	100%	up to 33%	up to 5%	None



Abrasive Particle

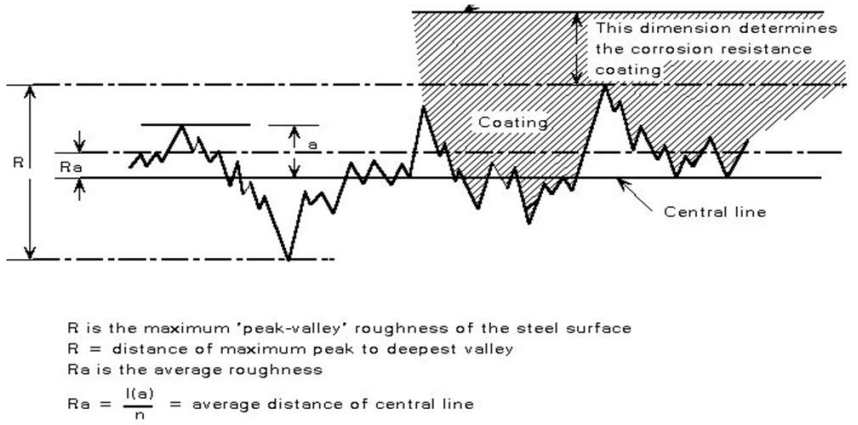


Figure 10 Influence of surface roughness on effectiveness of coating

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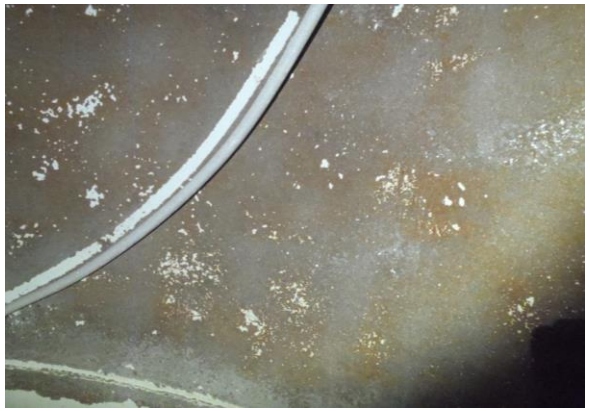
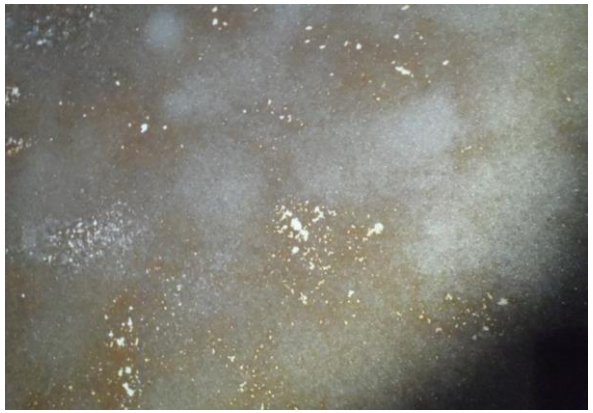
Coating System for Tanks - Examples of Poor Surface Prep





Coating System for Tanks - Results of Poor Surface Prep

Important Design Considerations | Interior Coating Selection

Interior System	Life Cycle	Examples	Cons	Pros
Epoxy	3-5 years	• Tnemec - N140 • SW - 646	• Impossible to cover steel adequately in one coat. • Worst cost for life cycle year. • No warranty • Not recommended by any paint manufacture for immersion. • No cathodic protection	• Low Cost • Some barrier protection
Epoxy/Epoxy	8-10 years	• Tnemec – N140 • SW - 646	• No cathodic protection • 1-3 year contractor warranty • Cost	• Barrier protection • Cost for life cycle year
Epoxy/Epoxy/ Epoxy	10-12 years	• Tnemec – N140 • SW - 646	• No cathodic protection • 1-3 year contractor warranty • Cost	• Barrier protection • Cost for life Cycle year • Medium cost
Zinc/Epoxy/Epoxy	18-20 years	• Tnemec –91h20(zinc) • Tnemec –94h20(zinc) • Tnemec – N140 • SW- Corothane 1 (zinc) • SW- 646	• Cost	• Cathodic protection • Longest life cycle • Cost for life cycle year • 15 year warranty from some paint manufactures • Some examples of 20+ years

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Important Design Considerations | Interior Coating Selection

Testing Standard:

- Salt Fog (ASTM B117)
- Results after 8,000 hrs.
- Same barrier protection provided by epoxy
- Different protection provided by primer

Epoxy (3 coats)

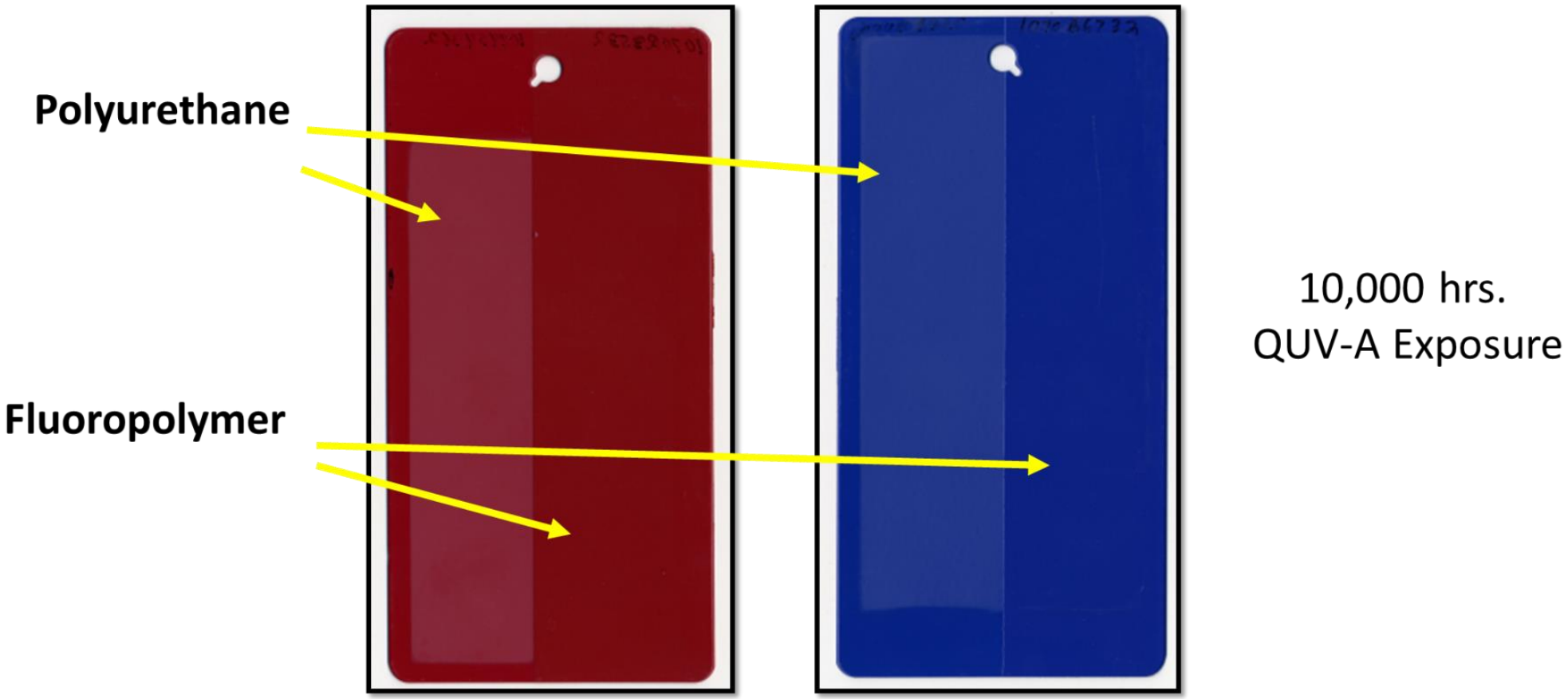
Zinc-Rich Primer
(1 coat) Epoxy (2 coats)

Important Design Considerations | Exterior Coating Selection

Exterior Top Coat Type	Life Cycle	Examples	Cons	Pros
Alkyd	3-5 Years	Tnemec - 82hs SW - B54	• Short life cycle • Must recoat with Alkyd • Prone to "Checking" • Fast to fade • Fast to chalk • Cost for Lifecycle year	• Low cost per gallon • Multiple color options • Easy application – One part system
Acrylic	5-7 Years	Tnemec - 1028,1029 SW - Sher-cryl	• Short life cycle • Fast to fade • Fast to chalk	• Low cost per gallon • Dry fall capable • Multiple color options • Easy application – One part system
Polyurethane	7-10 Years	Tnemec - 72, 73,740,1074 SW - 218	• Medium Life Cycle • Chalk in 5-7 years • Fade in 5-7 years • Medium cost per gallon • More difficult to apply – two part system	• Extended Life Cycle • Cost for Lifecycle year • Multiple color options
Aluminum	15+ Years	Induron- aluminum	• Fade in 3-5 years • Limited color options • Most difficult to apply	• Cost per gallon • Cost for Lifecycle year
Fluoropolymers	**18-20 Years**	**Tnemec - 700 SW - Flourkem HS**	• High Cost per gallon • More difficult to apply – two part system.	• **Best cost for lifecycle year** • **Multiple color options** • **Longest life cycle** • **Chalk in 18-20 years** • **Fade in 15-20 years** • **15 year color and gloss warranty**

Important Design Considerations | Exterior Coating Selection

Testing Standard: QUV (ASTM D 4587)



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Important Design Considerations | Coating Selection

Stripe Coats (Interior and Exterior)

- **Build paint thickness** (mils) on weld seams, sharp edges, ladders, brackets, pits, etc. (typical areas to show corrosion first)
- Apply by **brush/roller ONLY**

Independent Oversight and Inspection

What is National Association of Corrosion Engineers (NACE)?

- Global leader in developing **corrosion prevention** and **control standards**, **certification** and **education**

Why is NACE important?

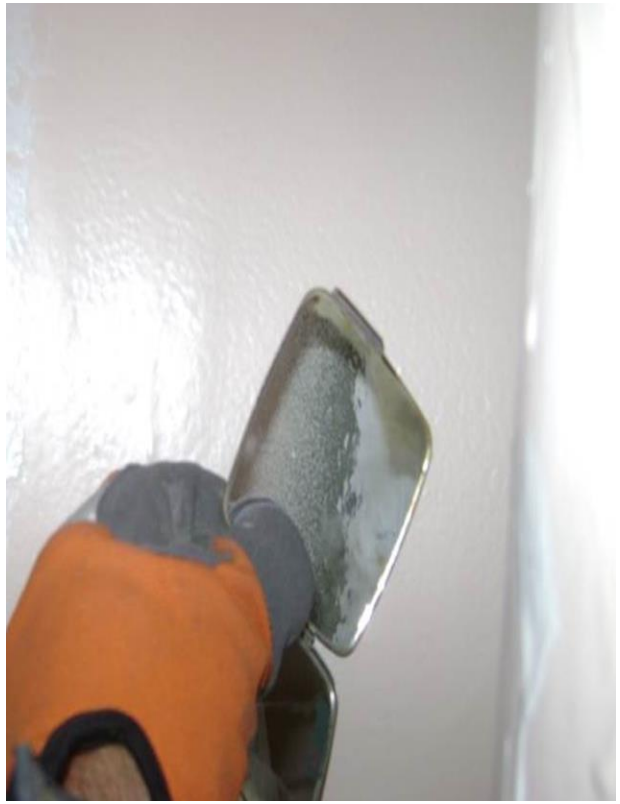
- Industry **leading technical education** for coating and corrosion expertise
- **Credibility**

What Can NACE do for your Tanks?

- **Extend coating lifecycles** with advanced assessment and inspection knowledge

Independent Oversight and Inspection

Hold Point Inspections



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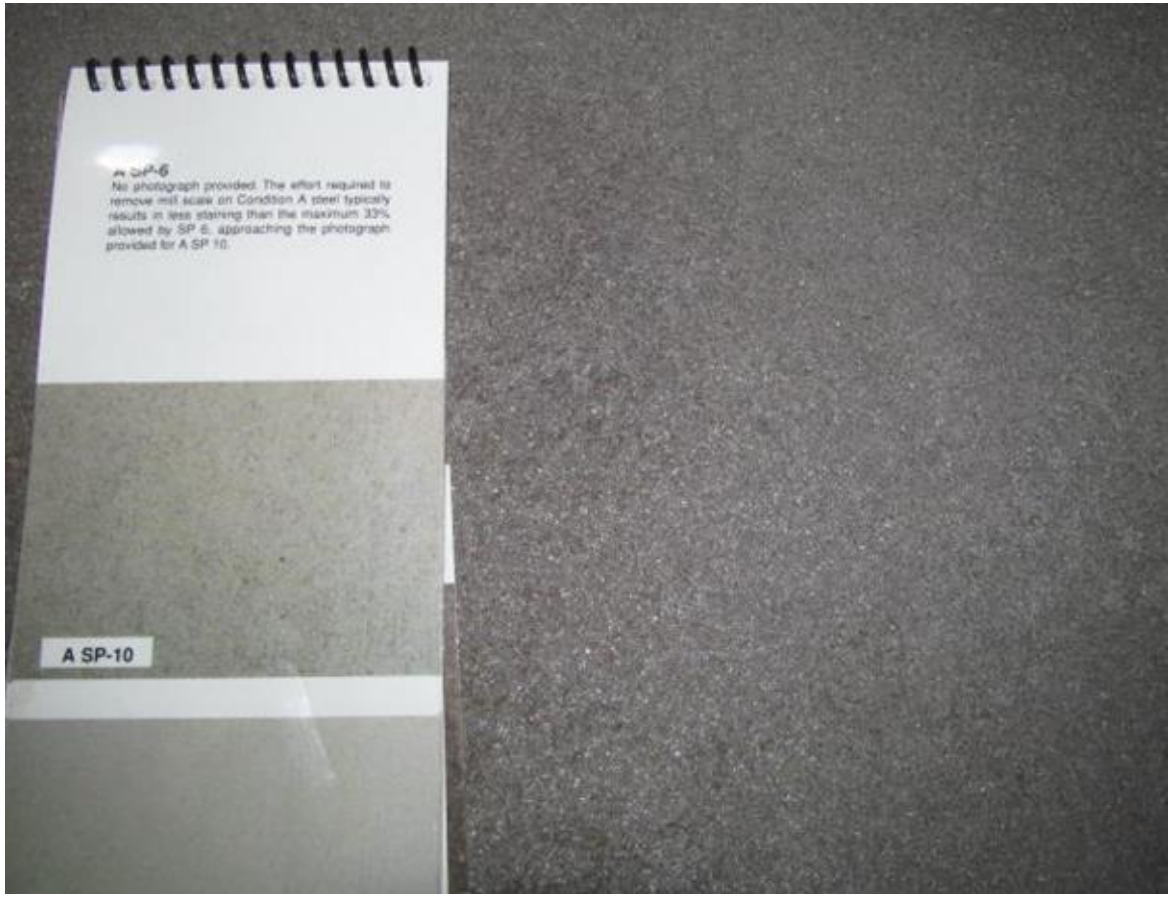
Independent Oversight and Inspection

Surface Prep



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Independent Oversight and Inspection

Weather Conditions

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Tank Design
Tank Construction
Existing Tank Assessment
Existing Tank Rehabilitation

Existing Tank Condition Assessment

Routine Tank Inspections

- Why inspect your tanks?
- Evaluation tank appurtenances (vents, overflows, access hatches, ladders, etc.)
- Structural evaluation
- Coating evaluation
- Upgrades
- Complete detailed inspection report
- Use inspection report to develop detailed specifications for the rehabilitation of the tank

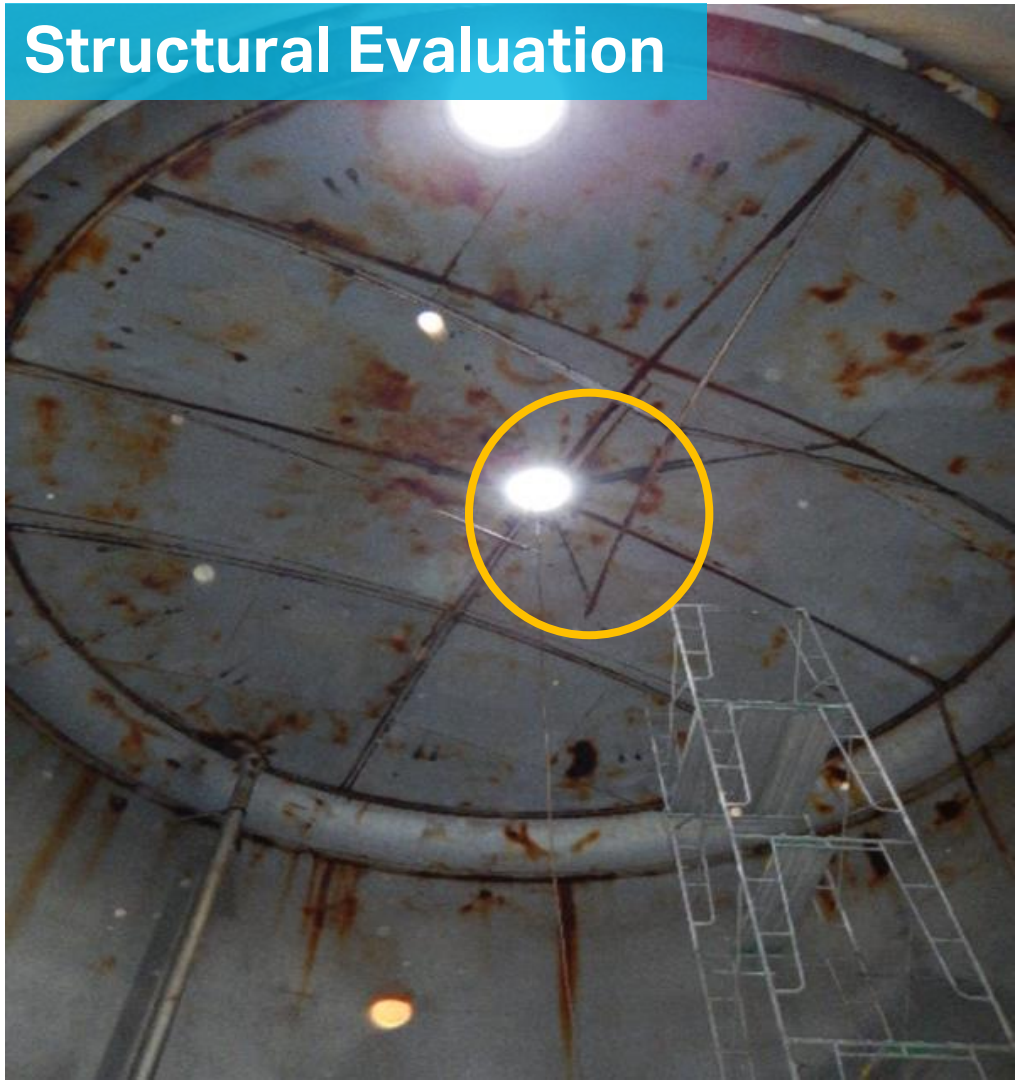
Jamie inspecting a tank for the City of West Columbia, SC

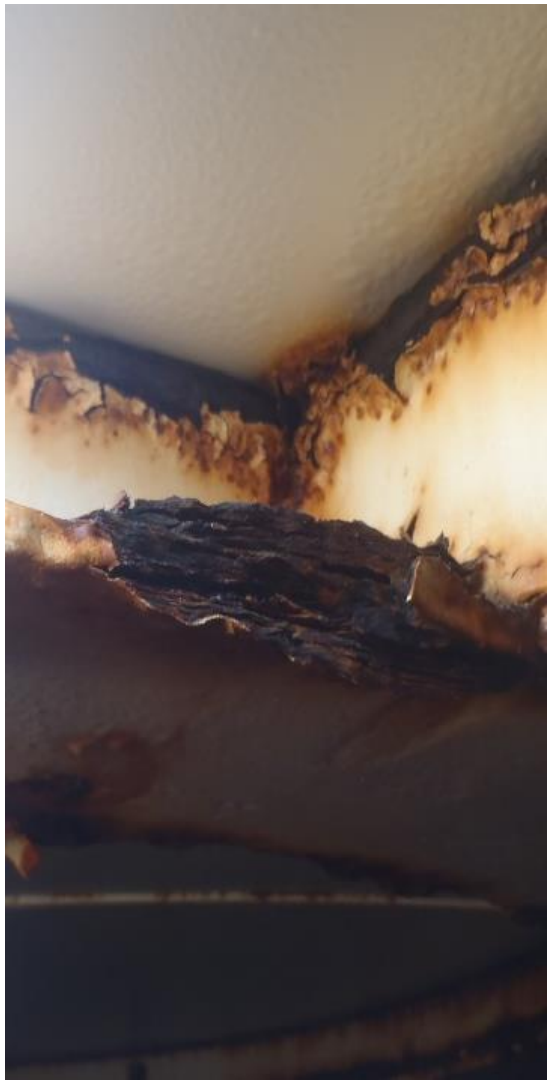
Routine Tank Inspections

Evaluation of tank appurtenances
(vents, overflows, hatches, ladders, etc.)

Routine Tank Inspections

Structural Evaluation

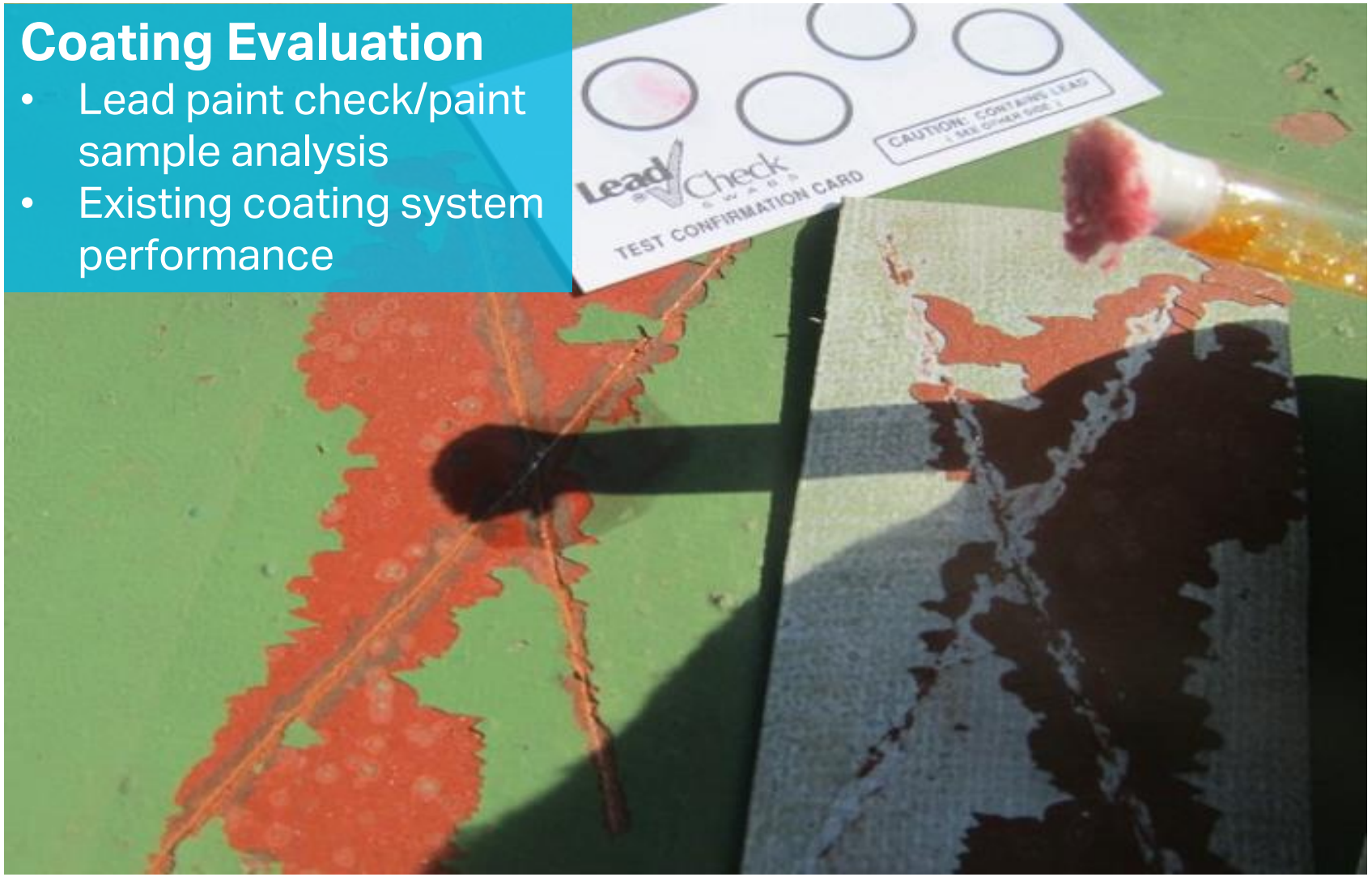


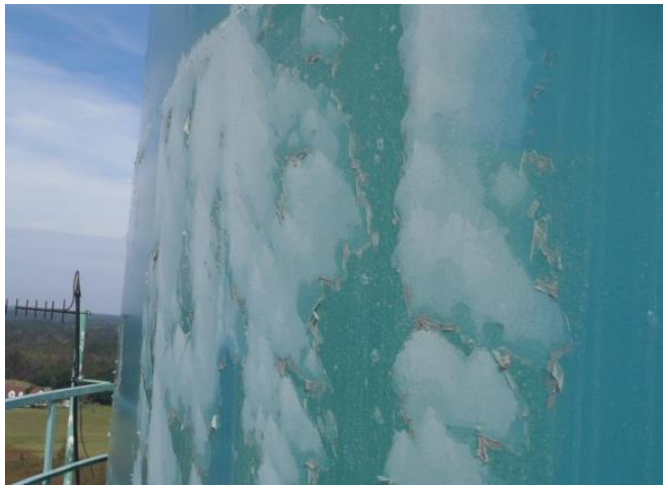


Routine Tank Inspections

Coating Evaluation

- Lead paint check/paint sample analysis
- Existing coating system performance





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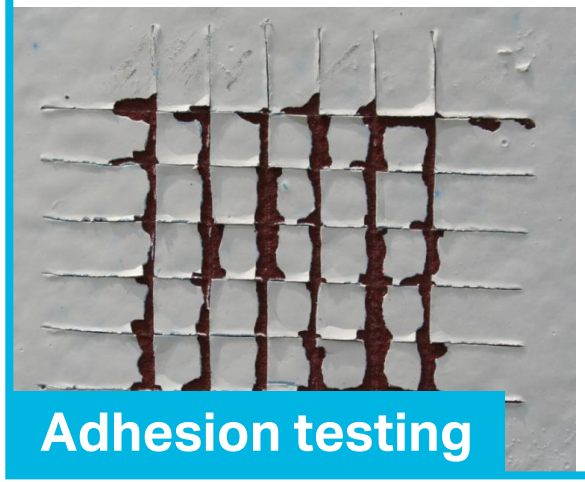
Routine Tank Inspections

Coating Evaluation



Adhesion testing

Paint thickness

Coating compatibility

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Routine Tank Inspections

Upgrades needed?

- Replace ladders?
- Replace overflow?
- Replace structural components?

Routine Tank Inspections

Complete a detailed inspection report of findings

- Repairs needed
- Coating requirements
- Cost estimate
- Prioritize needed repairs and upgrades

Use report to plan for future maintenance and repairs and to prepare detailed project specifications

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Important Design Consideration – An Experienced Design Team!

- Local and national experience
- Engineering team with decades of successful tank design, construction and tank rehab experience
  - Local **<u>NACE Certified Inspectors</u>**
  - As the old proverb says – *"The devil is in the details!"*

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QUESTIONS?

Thank You!

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