WATER STORAGE TANKS:

INSPECTION METHODS
Service Trucks
Would could go wrong?

H₂ Gas build-up
Tank Failure: 300,000 gal
Auburn, MA

Sidewall failure due to corrosion
Water Tank Styles & Design Issues:
Leg Tank
Single Pedestal
Fluted Column
Composite Elevated
Reservoir or Ground Storage
Bolted Tanks
Redwood Tank
Other Tanks...
Leg Tank
House Tank
EFFECTIVE TANK CONDITION ASSESSMENT OVERVIEW

- AWWA STANDARDS
- WHY INSPECT?
- SELECTING AN INSPECTOR
- WHAT TO INSPECT
- INSPECTION FREQUENCY
- INSPECTION TYPES
AWWA Standards

- **AWWA D100**
  Welded steel tanks for water storage

- **AWWA D102**
  Coating steel water storage tanks

- **AWWA C652**
  Disinfection of water storage facilities

- **AWWA G200-04**
  Distribution Systems Operation and Management

- **AWWA C655-09**
  Field Dechlorination
WHY INSPECT?
WHY INSPECT?

• AWWA M42 (1998): Chapter 9

“A good, comprehensive preventive maintenance program can extend the life of an existing tank indefinitely.”
WHY INSPECT?

• AWWA M42 (1998): Chapter 9

“Many thousands of dollars can be saved and complaints from citizens can be eliminated if a planned approach to tank maintenance is adopted.”
WHY INSPECT?

- AWWA “Steel Water Storage Tanks” (2010) Chapter 10, Page 381:

  “Why have a maintenance program? The answer is simple: Preventive maintenance has been, and always will be, less expensive than crisis maintenance.”
WHY INSPECT?

• DETERMINATION OF MAINTENANCE NEEDS FOR ONE OF THE WATER SYSTEMS MOST VALUABLE ASSETS:

SANITARY CONDITIONS
STRUCTURAL CONDITIONS
SAFETY CONDITIONS
COATINGS CONDITIONS
SECURITY CONDITIONS
HOW TO SELECT AN INSPECTOR?

• “Only organizations and individuals that are qualified and equipped to do the work should do inspections.”

• Ask for qualifications of inspectors
• Request sample inspection reports
• Request adequate insurance certificates
INSPECTION CONTRACTS:

• Require a written contract that defines the scope of the inspection:
  
  – should cover all (6) general categories
  – provide for pressure relief valves, or portable potable pressure tanks, and all other equipment necessary to conduct a safe and thorough inspection
  – state method of disinfection
  – State method of field de-chlorination
  – furnish insurance certificates naming tank owner as an additional insured
INSPECTION REPORTS:

• Report should include quality videotapes or color photographs documenting findings
• Report should be detailed and cover conditions under all (6) categories
• Report on all conditions NOT just deficiencies
• Provide recommendations and cost estimates
OWNER NOTIFICATION:

• “Any sanitary defect, contamination, safety hazard or serious structural damage found should be reported at the time of the inspection so the facility owner can have them corrected immediately.”
WHAT TO INSPECT:

- Six general categories of items on storage facilities that *must* be inspected:
  - Structural Conditions
  - Safety Conditions
  - Sanitary Conditions
  - Coating Systems Conditions
  - Security Conditions
  - General Details
Sanitary Conditions

- Roof Openings
- Access Hatches
- Low Spots on Roofs
- Vents
- Overflows
Sanitary Conditions: Roof Openings
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Sanitary Conditions: Roof Openings
Sanitary Conditions: Roof Openings
Sanitary Conditions: Roof Openings
Sanitary Conditions: Roof Openings
Sanitary Conditions: Access Hatches
Sanitary Conditions: Access Hatches
Sanitary Conditions: Access Hatches
Sanitary Conditions: Access Hatches
Sanitary Conditions: Low Spots on Roof
Sanitary Conditions: Vents
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Sanitary Conditions: Vents
Sanitary Conditions: Vents
Sanitary Conditions: Vents
Sanitary Conditions: Vents
Sanitary Conditions: Vents
Sanitary Conditions: Vents
Sanitary Conditions: Secure Vent
Sanitary Conditions: Overflows
Sanitary Conditions: Overflows
Sanitary Conditions: Overflows
Sanitary Conditions: Overflows
Sanitary Conditions: Overflows
Sanitary Conditions: Overflow
Overflow pipe full of dead birds
Safety Conditions

• Regulations

• Appurtenances
  – Ladders
  – Fall Prevention
  – Handrails
  – Access
  – Confined Space
  – Radiation
Safety Conditions: Regulations

- OSHA (Occupational Safety and Health Administration)
  - 29 CFR 1910: General Industry
  - 29 CFR 1926: Construction Industry
Safety Conditions: Fixed Ladders

• 29 CFR 1910.27
  – Minimum design load of 200 lbs.
  – 12 in. rung distance
  – 16 in. minimum side rail distance
  – 7 in – 15 in. toe clearance
  – 76 – 90 degree pitch
  – 15 in. clearance from centerline
  – 30 in. headroom
Safety Conditions: Fall Prevention

• 29 CFR 1926.502
  – A fall protection system must be used when working 6 feet or more above a lower level

• Systems include
  – Guardrail Systems
  – Safety Net Systems
  – Personal Fall Arrest Systems
  – Positioning Device Systems
  – Warning line Systems
6ft RULE
Guardrail Height

Top Handrail should be 42” (+ or – 3”) to the top of the rail
Mid Handrail should be 21” or midway between the toprail and the platform

Toeboard should be minimum 3 1/2”
Safety Conditions: Fall Prevention
Safety Conditions: Fall Prevention
Safety Conditions: Fixed Ladders
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Safety Conditions: Fixed Ladders
Safety Conditions: Handrail Systems

- 29 CFR 1910.23
- Handrail shall consist
  - Top rail 42” tall (200 lb force)
  - Toe board
  - Intermediate rail
  - No openings greater than 19”
  - 2”x2”x3/8” posts 8’ intervals
Safety Conditions: Handrail Systems
Safety Conditions: Handrail Systems
Safety Conditions: Access

- **29 CFR 1910.37**
  - Minimum of 22"
  - "Every building or structure .... the blocking of any single means of egress due to fire or smoke, shall have at least two means of egress remote from each other, “

Source: AWWA M-42
Safety Conditions: Access

- **AWWA D100**
  - Section 7.1 – "Two manholes in the first ring of the tank shell"
  - Section 5.1.2 – "manhole shall not be less than 12in. x 18in."
  - Section 5.6.1 – Opening above the water line
  - Section 5.6.2 - Opening near the tank center
    - “shell manway may be substituted”
Safety Conditions: Access
Safety Conditions: Access
Safety Conditions: Radiation

- FCC Issues
  - Hazard Communications
  - Safety Plan
Security Conditions: Threats

- Terrorist Acts
- Disgruntled Employees
- Pranks
- Environmental
Security Conditions
Security Conditions: Site Access
Security Conditions
Security Conditions
Security Conditions
Security Conditions
Security Conditions
Security Conditions: Bullet Hole
Structural Conditions

- Anchor bolts
- Foundations
- Wind rods
- Riser/Shell steel
- Spider Rods
- Roof Trusses
- Weld Seams
Structural Conditions: Anchor Bolts
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Structural Conditions: Foundations
Structural Conditions: Wind Rods
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Structural Conditions: Roof Trusses
Structural Conditions: Weld Seams
Coatings Conditions

- Generic type and general condition
- Approximate percentage and type of coatings system failure
- Adhesion
- Coating System Thickness
- Extent of Pitting Damage
- Heavy Metal Presence
Coatings Conditions
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Sediment Removal
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INSPECTION FREQUENCY

• AWWA M42:

“The maximum interval for periodic inspections of the tank interior should normally be 3 years. It is usually advisable to wash out the tank at the time of inspection.” Page 67
ROV Inspection Device
INSPECTION FREQUENCY

• AWWA M42:

“… proper inspections cannot be conducted if sediment covers the bottom of the tank. Tanks should be washed out and inspected at least every 3 years, and where water supplies have sediment problems, annual washouts are recommended.” Page 88
TYPES OF INSPECTIONS

- **Routine:** daily/weekly
- **Periodic:** monthly/quarterly
- **Comprehensive:** 3-5 years
Types Of Inspections

- AWWA G200-04 Distribution Systems Operation and Management, Section 4.3.1.3 states:

  “The utility shall have a written inspection program outlining frequency, procedures and maintenance of records. The inspection program shall include such features as routine (daily/weekly); periodic (monthly/quarterly); and comprehensive (3-5 years) inspections.”
EFFECTIVE TANK CONDITION ASSESSMENT SUMMARY

- AWWA STANDARDS
- WHY INSPECT?
- SELECTING AN INSPECTOR
- WHAT TO INSPECT
- INSPECTION FREQUENCY
- INSPECTION TYPES
What Robotics offers

- Lower Cost
- Lower Risk
- Time savings
- Tanks remain ONLINE and Operational
Robots vs. Divers

- Decisions men make
- Liability/Safety
- Time efficiency
What do we inspect?

- Sediment

✓ What depth of sediment should be cleaned?
What do we inspect?

- **Sediment**
- **Tank Structure**
  - Floors: Tell a bigger story than simply how dirty it is
What do we inspect?

- Sediment
- Tank Structure
- Ceilings
  - Concrete problems / Steel tank problems
What do we inspect?

- Sediment
- Tank Structure
- Floors
- Ceilings
- Pipes, ladders, columns, hatches, vents and screens
What do we inspect?

• Sediment
• Tank Structure
• Floors
• Ceilings
• Pipes, ladders, columns, hatches, vents and screens
• **Cathodic protection and less metal in tanks**
What do we inspect?

• Sediment
• Tank Structure
• Floors
• Ceilings
• Pipes, ladders, columns, hatches, vents and screens
• Cathodic protection and less metal in tanks

• Specific Requests...
Common Problems

- Need to cut locks due to lost keys
- Structure failure
- Coating failures
Common Problems

- Need to cut locks due to lost keys
- Structure failure
- Coating failures
- Concrete cracks
Common Problems

- Need to cut locks due to lost keys
- Structure failure
- Coating failures in steel tanks
- Concrete cracks
- Animals
- Hatch minimums & other tank designs
Wrap Up

Robotic Solution =

✓ Lower Cost
✓ Lower Risk
✓ Time savings
✓ Tanks remain ONLINE and Operational
Chemical Cleaning for Water Storage Tanks

Kevin Barnes
Utility Service Co, Inc
15 Dec 2011
CHEMICAL CLEANING OF THE STORAGE TANK

Removal of Bio-film from all tank surfaces:

• Reduces disinfectant demand
• Reduces risk of nitrification
• Reduces risk of DBP formation

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CHEMICAL CLEANING OF THE STORAGE TANK

• Washout inspection involves sediment removal and pressure washing of tank surfaces followed by disinfection in accordance with AWWA C652.

• Pressure washing and the disinfection process will NOT kill and remove the bio-film on interior tank surfaces.

• Failure to remove the bio-film leaves a major source of disinfectant demand in the tank which simply regenerates during the summer months.

• A low pressure NSF 60 certified chemical application can remove all biological growth from the tank as well as the mineral staining typically associated with the bio-film.
CHEMICAL CLEANING OF THE STORAGE TANK

- In addition to the impact on disinfectant demand, bio-film and Fe/Mn stain removal makes inspection and repairs to failures in the coating much easier and more thorough.
- Maintaining the integrity of the coating is vital and will minimize biological re-growth by eliminating those anchor sites where colonization occurs.
- Our experience has shown a direct correlation between interior coating surface roughness and bio-film growth.
Organic Deposits on Tank Interior
Organic Deposits on Tank Interior
Bio Film on Tank Interior
Bio-film in Storage Vessels
CHEMICAL CLEANING OF THE STORAGE TANK

- PRESSURE WASHING ALONE WILL NOT REMOVE BIO-FILM, which is an ongoing source for chlorine consumption and DBP production
Bio-film removal process

Before

During

After
Bio-film Removal
Bio-film Removal