Coatings Maintenance Assessments

Webinar Objectives

• Introduction to coatings
• Planning for a safe inspection
• Field inspection equipment & techniques
• Assessing coating condition & examples
• Hazardous materials sampling
• Coating maintenance options
• Developing maintenance plan & strategies
Based on:

2014 Journal of Protective Coatings and Linings (JPCL) Editors’ Award
Introduction to Paints & Coatings

• **Ancient history**
  – 100,000 BC: ochre-based mixture—paint?
  – 40,000 BC: cave paintings drawn with red or yellow ochre, charcoal, other pigments

• **Today’s paints / coatings**
  – Architectural paints (latex house paints)
  – Concrete sealers (basements, driveways)

• **Protective coatings: robust properties**
  – Strong adhesion to the substrate
  – Controlled penetration of water and ions

*http://en.wikipedia.org/wiki/Paint
Introduction to Protective Coatings

<table>
<thead>
<tr>
<th>Thermoplastic</th>
<th>Thermoset</th>
</tr>
</thead>
<tbody>
<tr>
<td>One container</td>
<td>Two or more containers; except moisture-cured urethanes &amp; siloxanes and alkyds</td>
</tr>
<tr>
<td>“Dries” as solvents evaporate</td>
<td>“Cures” by chemical reaction</td>
</tr>
<tr>
<td>Vinyl, coal tar enamel, latex</td>
<td>Epoxy, polyurethane, coal tar epoxy, alkyd</td>
</tr>
</tbody>
</table>

- Paint (coating) = binder (polymer) + pigment & filler + solvent or diluent

- Barrier coatings are most common
  - High film build (coal tar enamel, polyurethane, epoxy)
  - Flake pigments to make tortuous path for water (aluminum, glass, etc.)
- Sacrificial (zinc-rich, metallizing)
- Inhibitive (lead, chromate)
Historical Coatings Used By Reclamation

- Coal tar enamel (still available, but limited application)
- CA-50 cold applied coal tar paint
- Red lead primer + phenolic aluminum topcoat
- Vinyl resins, VR-3, VR-6, VR-M
- Coal tar epoxy (still in use)

Phenolic lead + aluminum

CA-50

VR-6
Planning for a Safe Inspection
Planning a Safe Inspection

• Certifications
  – Fall protection (possibly rope access)
  – Confined space, permit required
  – Lock out tag out (LOTO) (now hazardous energy control program (HECP))

• Job hazard analysis (JHA) other considerations
  – Weather
  – Wildlife
  – Safety shoes, hard hats, hearing protection, other personal protective equipment (PPE)
  – Loose clothing
  – Coating sampling for hazardous materials
Potential Inspection Conditions

Partially-filled pipes (sand or water), rope access or fall protections techniques, poor weather, animals, and severely degraded infrastructure are possible.
Field Inspection Equipment & Techniques
Inspection Survey Types

• General visual: non-quantitative
  – Determine one of two parameters:
    • Condition (good, fair, or poor)
    • Rust rating (ASTM D 610)
  – Normally completed in a few hours
  – Suitable to distinguish severe conditions

• Detailed visual: semi-quantitative
  – Systematic survey of structural elements – support beams, connections, edges, etc.
  – Document reduced film thickness, coating deterioration, rust on edges or flat surface, and severe corrosion or metal loss
Inspection Survey Types – cont.

- Physical inspection survey: physical properties / destructive
  - Adhesion (ASTM D 3359, D 4541, or knife)
  - Film thickness (Tooke gauge) & number of coats
  - Sample paint chip (more on this later…)

- Helpful hints
  - Hold light source close to pipe wall to scan for raised blisters
  - Use mirrors to see around corners or hard to reach areas
  - Use binoculars or a good camera to see distances close-up
References – Inspection Standards

• SSPC – Vis 2
• ASTM D 610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
• ASTM D3359 - Standard Test Methods for Measuring Adhesion by Tape Test
• ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
• SSPC – PA 2 how to measure the dry film thickness (DFT) of coatings
• ASTM E213 - Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing
• ASTM E1444/E1444M - Standard Practice for Magnetic Particle Testing
• ASTM E709 - Guide for Magnetic Particle Testing Examination
Assessing Coating Condition & Examples
Maintenance Inspections

• Things to consider
  – Previous repairs, problem areas, construction challenges (limited outage, confined space, seepage control, etc.)
  – Coating condition—visual defects, film and ultrasonic thickness testing, hazardous materials testing
  – Service Conditions: atmospheric, burial, or immersion

• Maintenance options
  – Several may be feasible
  – Include funding perspective from facility owner

• Collect sample for hazardous materials if maintenance is likely
Common Adverse Conditions

- Chalking
- Cracking
- Blistering
- Uniform degradation
- Galvanic Corrosion
Typical Problem Areas

- Drips
- Water spray around leaking seal
- Splash zone
- Turbine runners & draft tube
Aged Coal Tar Enamel

Alligator cracking

Brittle failure at rivet

Heat differential (enters soil)

Corrosion at joint
Aged Epoxy Coating

Problem areas requiring repair

Typical condition of structure
Hazardous Materials Sampling
Assessing Coating Hazards

• Assume the existing coating contains hazardous material
  – Use appropriate PPE
    • Inhalation (breathing) – dust and fumes
    • Ingestion (eating)
  – Collect coating samples
    • Use sampling plan to document sampling and analysis
    • Use appropriate methods and laboratories

• Include test results in specification or statement of work
  – Do not assume level is too low to include in contract
    (include non-detects)
  – “Detectable” is any level above the method detection limit
Sampling Plan

- Sample several areas for each coating and create a composite
- Indicate exact sample locations (diagram, pictures, etc.)
- Use chain of custody procedure
- Methods (EPA, ASTM, NIOSH)
- Hazards to test for
  - Metals—lead, chromate, cadmium, arsenic, mercury, barium, selenium, silver
  - Non-metals—coal tar pitch, asbestos, polychlorinated biphenyls (PCBs), silicates
Sample Size & Approximate Cost

- **RCRA 8 Metals, EPA SW846 6010/6020**
  - Size: 5 grams
  - Cost: $150/sample; $15/metal if over ten metals

- **Asbestos, EPA 600/R-93/116**
  - Used in coatings, plasters, putty, and caulks
  - Size: – 2 square inches (all layers & types of surface represented)
  - Cost: $25/sample PLM bulk; $200/sample TEM

- **PCB, EPA SW846 8082**
  - Used in hundreds of industrial and commercial applications including as plasticizers and pigments in paints (vinyl, lead primers, aluminum topcoats, coal tar enamel)
  - Size: 30 grams
  - Cost: $80 to $140
References – Hazardous Materials Sampling

Regulations
• Clean Water Act – www.epa.gov/r5water/cwa.htm
• Clean Air Act – www.epa.gov/oar/CAA/
• CERCLA – www.epa.gov/superfund/action/law/cercla.htm
• TSCA – www.epa.gov/Region5/defs/html/tsca
• RCRA – www.epa.gov/region5/defs/html/rcra.htm
• OSHA – www.osha.gov/

Training (all SSPC)
• C3 – Supervisor / competent person training for deleading of industrial structures
• QP2 – Certification program (field removal of hazardous coatings)
• Guide 6 – Containing surface preparation debris generated during paint removal operations
• QP4 – Evaluating the qualifications of contractors disturbing hazardous coatings during demolition and repair work
• TU 7 – Conducting ambient air, soil, and water sampling during surface preparation and paint disturbance activities

Bureau of Reclamation contacts
• Kevin L. Kelly, 720-663-7944, kkelly@usbr.gov
• Allen Skaja, 303-445-2396, askaja@usbr.gov
Coating Maintenance Options
Maintenance Painting Options

• No painting
  – Deferral of maintenance
  – Decommission planned
• Spot repairs
• Spot repairs & full overcoat
• Total removal and recoat
• Alternatives / additions
  – Install cathodic protection
  – Replacement (in kind, plastics, composites, etc.)

• Progressively increase in complexity, work, & expense

See SSPC- Guide 5 Maintenance Painting Program
Deferral of Maintenance

• Coating is in good condition
• Structure’s service life is limited
• Full recoat almost required (> 10% damage)
• Full recoat required but allocate funds to maintaining other coatings
• A contributing deficiency must be resolved first (example: control leaks, seepage, or drips)

Fix leaks!

Fix seepage!
Spot Repairs

- Document or approximate the number of repairs needed
  - May be cost prohibitive at > 15% of area
  - Add a few inches around perimeter to feather
- Where do you draw the line?
Spot Repair with Full Overcoat(s)

• Not recommended if existing coating is embrittled, flaking, cracking or loose (minimal adhesion)

• Assess existing coating
  – Thickness, age, type of coating, number of coats, chalking, adhesion, cohesion, surface contaminants, amount of rust
  – Test coating compatibility via test patches (ASTM D 5064)
  – For atmospheric exposure only!

• Drawbacks
  – Coating failure is possible
  – Lead remains on structure

See SSPC TU 3 – Overcoating
Total Removal and Recoat

- Economical for > 15% repairs (rule of thumb)
- Restarts maintenance cycle

Coal tar enamel lining (70+ years)

Corrosion cell

Coal tar enamel lining
Ideal Maintenance Cycle

1. Total removal and replacement starts the new cycle
2. Several rounds of spot repairs
3. Spot repair with full overcoat (except immersion)
4. Coating adhesion degrades to the point where addition repairs are no longer practical

Example:

<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
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<tbody>
<tr>
<td>0</td>
<td>Initial painting</td>
</tr>
<tr>
<td>8</td>
<td>Spot repair</td>
</tr>
<tr>
<td>12</td>
<td>Spot repair</td>
</tr>
<tr>
<td>16</td>
<td>Spot repair + overcoat</td>
</tr>
<tr>
<td>22</td>
<td>Full recoat</td>
</tr>
</tbody>
</table>

Cathodic protection can extend service life in some circumstances

See NACE 2008, Paper 08279
Progression of Maintenance Project

- **Scope definition**
  - What items will receive painting maintenance?
  - What items must be protected or treated separately?
    - Mating and machined surfaces
    - Mechanical or electrical equipment
    - Instruction and similar plates

- **Coatings specification**
  - Guide specification available online
  - Contract TSC for services

- **Construction Support:**
  Quality Assurance
  (NACE CIP or similar)
Developing Maintenance Plan & Strategies
Developing a Maintenance Strategy

- **Funding**
  - What is the funding source for maintenance?
  - Does it cover regular inspections, repairs, and replacement?

- **Infrastructure**
  - What type of infrastructure requires protection?
  - Is it a single substrate type such as steel, concrete, etc.?

Structure is a steel liner in immersion exposure
Developing a Maintenance Strategy Cont.

- Exposure – what exposure(s) does it receive?
- Special construction needs
  - What is the accessibility? Confined space? Strict outages?
  - Can it be recoated without interrupting operations?
  - Does the present coating contain hazardous materials?

Structure has intermittent immersion and UV exposure

Challenge is to maintain over water source
Thank you for your attention! Questions?

Cathy Chan  
M.S. Materials Engineering  
cchan@usbr.gov  
303-445-2390

Bobbi Jo Merten  
Ph.D. Coatings and Polymeric Materials  
bmerten@usbr.gov  
303-445-2380

Rick Pepin, PCS  
Materials Engineer  
rpepin@usbr.gov  
303-445-2391

Allen Skaja, PCS  
Ph.D. Coatings and Polymeric Materials  
askaja@usbr.gov  
303-445-2396

David Tordonato, P.E.  
Ph.D. Materials Engineering  
dtordonato@usbr.gov  
303-445-2394

Chrissy Daniels  
Materials Engineer  
cdaniels@usbr.gov  
303-445-2348

Daryl Little  
Ph.D. Materials Engineering  
dlittle@usbr.gov  
303-445-2384

Lee Sears, P.E.  
Ph.D. Materials Engineering  
lsears@usbr.gov  
303-445-2392

Roger Turcotte, P.E., CPS  
Materials Engineer  
rturcotte@usbr.gov  
303-445-2383

Jessica Torrey  
Ph.D. Materials Science and Engineering  
jtorrey@usbr.gov  
303-445-2376