Lou Taylor - Biography

• **Liberty Sales and Distribution** 2009 - Present
  - Mid Atlantic Sales Manager
  - Outside Sales & Technical Support

• **Baltimore Gas & Electric** 1988 - 2009
  - Gas Materials Specialist
  - Engineering Technician
  - I&C Metering Welder / Pipefitter

• **NACE – CIP 1 – CP 1 & PCS 2**
• **AUCSC – GENERAL COMMITTEE**
• **AGMSC – GENERAL COMMITTEE**
• **MASTER GAS FITTER STATE OF MARYLAND & BALTIMORE CITY**
• **AWS CERTIFIED STRUCTURAL STEEL WELDER**
DIRECTIONAL Drilling

• Trenchless technology utilized for installing pipelines
• May be an option for pipe installation in high consequence areas (HCA)
• Used at obstacles such as river crossings, under roadways, railroad tracks, etc.
• Minimizes the impact on the environment due to minimal disturbance of the soil in the ROW
• Utilized across a wide range of industries
Directional drill bores
WHY USE HDD

• More economical way to install piping in an inaccessible area as opposed to open cut trench
• Utilized when some of the following are encountered:
  • Structure, geographical obstacles, population impact

Process:
• Geological mapping & evaluation of area to be drilled is conducted
• Fabrication of pipeline to be installed
  • Need sufficient lay down area for pipe prefabrication
  • Field prep and coating of welded joints with acceptable drill coating
  • Field joint coating is critical due to the abuse during the pull
• Borehole drilling
• Casing installation (if cased)
• Pull-through of fabricated pipeline
DOT REGULATIONS

• 49 CFR 192.455 External corrosion control: Buried or submerged pipelines

a) Except as provided in paragraphs (b), (c), and (f) of this section, each buried or submerged pipeline installed after July 31, 1971, must be protected against external corrosion, including the following:

(1) It must have an external protective coating meeting the requirements of § 192.461.

(2) It must have a cathodic protection system designed to protect the pipeline in accordance with this subpart, installed and placed in operation within 1 year after completion of construction.
§ 192.461 External corrosion control: Protective coating.

(4) Have sufficient strength to **resist damage due to handling and soil stress**; and

(5) Have properties **compatible with** any supplemental **cathodic protection**.

(b) Each external protective coating which is an electrically insulating type must also have low moisture absorption and high electrical resistance.

(c) Each external protective coating **must be inspected just prior to lowering** the pipe into the ditch and backfilling, and any damage detrimental to effective corrosion control must be repaired.

(d) Each external protective coating **must be protected from damage** resulting from adverse ditch conditions or damage from supporting blocks.

(e) If coated pipe is installed by boring, driving, or other similar method, precautions **must be taken to minimize** damage to the coating during installation.

**This is where ARO coatings need to be considered**
Specialty HDD Coatings

• “Temporary” or “Sacrificial” coatings -- must survive during the installation and have the ability to protect the CP coating they are protecting

• May change based on the terrain or environment they will be utilized in

• Choice of abrasion resistance and toughness vs. lubricity
  • Lubricity is how much wear is caused to a surface by a given wear inducing object in a given amount of time.
So, What to Use?

- Dependent upon your specific HDD requirements which include:
  - Geological information
  - Pipe size, wall thickness, pull length
  - HCA location
  - Deflection requirement (how much bending will the pipe encounter) *SEE next slide for deflection concern*
  - Any temperature limitations to consider either low or high?
    - Not only exterior of pipe but interior product temperature as well

- Pipeline contractor (and coating applicator) experience

- Initial corrosion coating selection
  - On site vs. plant application

- Cost
Coating damage due to too much deflection

Did the cracking cause damage to the FBE under it?
Overview of Potential Damage types and coating needs

Damage is generally caused by one of or more of these factors:

- **Gouging** - The material will successfully protect the coating system and prevent coating scarring or failures

- **Abrasion** – Material should perform above the level of typical coatings which is needed to withstand through the pull

- **Shear disbondment** - Materials need to adhere and be flexible enough to survive the bending during a pull even with increased thickness of the coatings

- **Impact** - The material is tough enough to withstand the impact it is subjected to during pull through
PHYSICAL TESTS For Coatings

THEY EVALUATE ABILITY OF COATING TO WITHSTAND:

- PULLING AROUND BENDS WITHOUT DISBONDING
- SLIDING THROUGH BENDS
- PULLING OVER BEDROCK OR SOIL
- DRAG FORCES FOR ENTIRE LENGTH OF PULL
- PROTRUSIONS, SHARP OR DULL
- ROCK SHIFTS
Tests Specific to HDD Coatings

- Gouge Resistance
- Adhesion to corrosion coating
  - Most HDD coatings are a sacrificial layer and are not the corrosion protection coating
- Abrasion Resistance
- Flexibility
- Penetration Resistance
- Impact Resistance
Standard Test Method

Test Method for Measurement of Gouge Resistance of Coating Systems
NACE TM0215
Gouge Test

Figure 1: Schematic of a Gouge Test Apparatus

Movement of 75mm at a speed of 250mm/min

Gouge tool (bit or burn)

Coated test panel

Motor to move test panel carrier

Load of 30/50 kg

AUCSC
Appalachian Underground Corrosion Short Course
ADHESION TESTS

- ASTM D4541
- Pull-off test, measures force/stress required to pull the coating from the substrate
- Difficult to interpret sometimes because of cohesion failures
- Questionable for sacrificial coatings

COATED PANEL

AIR-DRIVEN PISTON CONTROLS

DOLLY WITH PULL MECHANISM
ABRASION WHEEL

• ASTM D4060 Taber Abrasion

• Abrasive wheel grinds at rotating coating, measure weight loss or thickness lost per number of cycles
DRUM ABRASION

- ASTM G6 - Drum filled with sharp rocks, tumbles over sample, monitor resistance until holidays are created
FLEXIBILITY

• NACE RP0394, CSA Z245.20-98
• Test temperature variable
• Bend coating over mandrel, look for crack/holiday and shear disbondment; simulates pipe bending during pull
FLEXIBILITY

- DON’T WANT THIS! (shear disbonding)
FLEXIBILITY

BENT RING TEST

Typically used more for steel or weld strength
PENETRATION RESISTANCE
IMPACT TEST

- ASTM G14
- Test temperature variable
- Drop weight on coating, examine for holiday creation
Common **Mainline** HDD Coatings are REFERRED TO AS: ARO - Abrasion Resistant Overlay

- **EPOXIES AND POLYURETHANES**
  - FUSION BOND EPOXY (FBE)
  - LIQUID EPOXY
  - POLYURETHANE

- **POLYOLEFIN-BASED**
  - 3-LAYER POLYETHYLENE (3LPE)
  - 3-LAYER POLYPROPYLENE (3LPP)

*Polyolefin’s are the most widely uses plastics today and are very versatile with properties including flexibility, strength, lightness, stability, impermeability (to water and other liquids)*
COATINGS **NOT** Commonly used in HDD Due to Minimal protection they provide against the abuse encountered from HDD

- TAR-BASED THERMOPLASTICS
  - COAL TAR ENAMEL (CTE)
  - ASPHALT ENAMEL
  - BITUMEN
  - HOT-APPLIED & COLD-APPLIED TAPES

- OTHERS
  - PETROLATUM
  - WAX
  - VISCOELASTICS
  - Non ARO 2pt liquids
FBE/ARO Mainline Coatings

• FBE coating applied in higher mil thickness alone

• Extra abrasion protection added to outer layer Abrasion Resistant Overcoat (ARO)
Advantages/Disadvantages
FBE/ARO

FBE and ARO
• Can be applied at the same time as FBE corrosion coating
• Compatibility between coatings assured
• Good adhesion to steel
• ARO – fillers increase abrasion resistance over FBE

• Poor flexibility if applied too thick
• Not impact resistant
• ARO is multiple times the price per mil of FBE to apply
• Less lubricity for boreholes which are gravelly
**Typical ARO Weld Coatings**

Used on FBE/ARO coated mainline
- Field Applied FBE or FBE/ARO Combination
- 2-part Liquid Epoxy Systems
- Heat Shrink Sleeves *(designed for HDD)*
- Fiber Cloth With Resin *(mechanical protection only)*
  - Moisture Cured Outer wraps MCO
2-part FIELD APPLIED Liquid

Key considerations for field use

- Ensure no oils or contamination are present prior to blasting
- Should verify quality of air being used for blasting with blotter paper or similar as suggested per ASTM D4285 (test method for indicating oil or water in compressed air).
- Need to media blast to NACE 2 near white metal finish
  - NEVER BLAST WITH SAND DUE TO SILICA AND CHLORIDE CONTAMINATION
- Must measure anchor profile of blasted substrate 2.5 -4mil are required by most mfg..
- Temperature of substrate must be at least 50F or warmer and at least 5F above the dew point with means of checking dew point at the field application location.
Heat Shrink Sleeve specifically designed for HDD

- Key considerations for use
  - Ensure no oils or contamination are present prior to blasting
  - Should verify quality of air being used for blasting with blotter paper or similar as suggested per ASTM D4285 (test method for indicating oil or water in compressed air).
  - Blast to SA 2 ½ equal to NACE 2 near white metal
  - Pre-Heat substrate to mfg. recommended temp for epoxy application then as required for sleeve application
  - Ensure sacrificial sleeve is applied in the direction of the pull

Wet or Force Cured *Epoxy* System to Bare Steel

Adhesive

Primary Sleeve

Sacrificial Sleeve
<table>
<thead>
<tr>
<th>PROPERTIES</th>
<th>STANDARD</th>
<th>REQUIREMENT</th>
<th>DDX</th>
<th>STD. MET?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to Gouge Forces</td>
<td>-</td>
<td>Comparative</td>
<td>21 mils avg. (Excellent)</td>
<td>✓</td>
</tr>
<tr>
<td>Soil Stress Resistance</td>
<td>EN 489</td>
<td>PASS</td>
<td>PASS</td>
<td>✓</td>
</tr>
<tr>
<td>Abrasion Resistance</td>
<td>ASTM D1044</td>
<td>Comparative</td>
<td>&lt; 6 mg loss (Excellent)</td>
<td>✓</td>
</tr>
<tr>
<td>Resistance to Cathodic Disbondment</td>
<td>EN 12068 (28 days/23°C)</td>
<td>&lt; 15 mm</td>
<td>&lt; 3 mm</td>
<td>✓</td>
</tr>
<tr>
<td>Adhesion Strength</td>
<td>EN 12068</td>
<td>&gt; 7.5 N/cm</td>
<td>&gt; 125 N/cm</td>
<td>✓</td>
</tr>
<tr>
<td>Impact Resistance</td>
<td>EN 12068, Class C</td>
<td>No Holidays</td>
<td>No Holidays</td>
<td>✓</td>
</tr>
<tr>
<td>Indentation Strength</td>
<td>EN 12068, Class C</td>
<td>&gt; 0.6 mm remaining</td>
<td>&gt; 1.0 mm remaining</td>
<td>✓</td>
</tr>
<tr>
<td>Resistance to Hot Water Immersion</td>
<td>50°C, 3% NaCl for 180 Days</td>
<td>No Signs of Moisture Ingress</td>
<td>No Change</td>
<td>✓</td>
</tr>
</tbody>
</table>
Importance of Proper Surface Prep

• Corrosion Protection starts from the surface of the pipe out.
• All substances that could interfere or prevent the coating from bonding to the substrate must be removed prior to the coating.

Remove:
  o All loose Rust, Salts, Dirt and Dust
  o Moisture, Grease, Oil, Mill Lacquer & Shop Coating
  o Sharp Edges, Burrs, Weld Slag, Mill Scale

• Pre-Heat: (when applicable) substrate to Mfg.'s specifications
• Blast Clean: to NACE 2/SSPC-SP 10 standards

Refer to: Manufacturers Installation Guides to determine the appropriate surface preparation procedures for the coating you are using.

Without PROPER surface preparation the coating will FAIL
Anchor Profile Verification

- **Quality Control**

- **Near-White Metal** (SSPC-SP10, NACE 2, Sa 2 ½) or better.

- **Blast profile should be 2.5-5 mils** (refer to specific mfg. installation guide requirements)

Near White Surface prep

Testex Tape w/micrometer to verify anchor profile
Anchor Profile & Epoxy Wet-Out

Why Is This A Critical Step?

Epoxy has **NOT** flowed into the Anchor and Surface cavities

- Common causes:
  - Anchor profile too deep
- Too much pre-heat

Epoxy **HAS** flowed into the Anchor and Surface profiles The Adhesive has “Wet-Out”

This process is equally important for mainline and field applied coating in effort to provide long term corrosion protection
PREHEATING - Weld Joint & Adjacent Coatings

- **Substrate Temperature**
  - Substrate 50°F min for most 2pt liquids
  - Time & Temperature Dependent

- **Dew Point**
  - Substrate Temperature 5°F above the Dew Point
  - DP is the temperature at which moisture condenses

- **Dry & Clean Surface Area**

- **Achieve Faster Cure Times**
  - YOU CAN OVER HEAT. You must refer to mfg.'s max pre-heat requirements or you will fry the coating.
Confirm substrate is clean after blasting prior to applying 2pt liquid or shrink sleeve

- After blasting there is a chance that contaminants may still be present on the substrate and blowing off with air or using a brush alone to clean may not fully remove all contamination.

- Use of Acetone or MEK can ensure these contaminants are fully removed may be needed.

- If you are going to clean with a liquid you must use something that evaporates 100%.
Field Applied Weld Coatings

The majority of coating failures which happen in the field are generally a result of one of the following:

- Improper coating selected for the specific job
- Field applied coating is not applied properly
- Based on the depth of your drill are you confident you will be able to evaluate the effectiveness of your coating in the future for any damages, if not you may want to consider the addition of an MCO for added protection
Moisture Cured Outerwrap (MCO)

- Due to their extreme resistance to gouging and other damage, fiber cloths with resin (MCO) have evolved to further add in protection of the field applied weld coatings as well as an extra added layer of sacrificial protection on the mainline coating for extreme HDD applications.
MCO Adds Additional Sacrificial Layer Of Protection
Soil conditions
- Will the coating survive pull back?
- What is the cost of re-pulling?
- What is the cost to abandon the pipe?

Will anomalies be found?

Spot repairs
- Will spot repairs be possible?

How much will re-pull and repair cost if you have coating issues after installation?

Will the pipe need repositioning during the pull causing potential added abrasion due to back and forth motion?
Unknown Drilling Conditions

You never really know what is in the ground with HDD applications.

The soil survey for this project was classified as “good drilling conditions”

This rock was 200’ from the bore entrance
Polyurethane mainline coating

- Spray on systems
- High Build Molded Systems
Advantages/Disadvantages Polyurethanes

• Can apply on-site
• Capable of very thick film builds
• Fast curing
• High Lubricity – Low Friction
• Good Flexibility
• Excellent resistance to Salt and Fresh water (low water absorption)

• Not very tough, must apply thicker to get protection
• Lower Adhesion in comparison to other systems
Typical ARO Weld Coatings For Polyurethane coating

Used on Polyurethane coated mainline
- Spray or brush applied Polyurethane
- Heat Shrink Sleeves
- Fiber Reinforced Urethanes
- IMPU – Injection molded PU
- Not used much in the Mid-Atlantic area as mainline
Multi-Layer Mainline Coatings
polypropylene and Polyethylene

- Polypropylene (PP) and Polyethylene (PE) outer layer acts as mechanical protection to the FBE layer
- PP and PE systems have capability to withstand elevated temperatures
Advantages/Disadvantages
Multi Layer PP/PE

- Already a standard pipeline
- Polypropylene (PP) and Polyethylene (PE) outer layer acts as mechanical protection to the FBE layer
- PP and PE systems have capability to withstand elevated temperatures

- Poor gouge resistance
- Potential issues with CP shielding
Typical ARO Weld Coatings

Used on Polyurethane coated mainline

- Heat Shrink Sleeves
- Fiber Reinforced Urethanes
- IMPU – Injection molded PP/PE
- Flame Sprayed PP/PE
- Not commonly used in Mid-Atlantic
Damage to HDD Coatings

Generally one of 2 forms

• Gouging – from dragging through sharp rocks
• Shear disbondment / bending – due to bending of excessively thick coatings

Note: gouge-resistant coatings usually are not very flexible!!
Gouging from HDD
Abrasión Wear from HDD
Shear Disbondment

Typical casing damage during a pipe pull-in
Abrasion from HDD
CONSIDERATIONS FOR IN-SERVICE PROPERTIES

• The CP coating must still have the ability to perform as the initial line of defense against corrosion

• Cathodic protection interaction
  • If impressed current system applied on either side of HDD, over potentials could be encountered
  • Excessive thickness can lead to shielding of CP
CP IN DISBONDED AREA

Occurs at holidays, disbonded / damaged area and is protected locally
CATHODIC DISBONDMENT

- Occurs at holidays, disbonded area protected locally
- Creation of holidays during HDD installation
- Extra coating thickness could lead to CP shielding if not designed properly
- Potential for excessive disbondment in some areas if cathodic protection is not uniformly distributed
ASSESSMENT OF AN HDD COATING Performance

• Often evaluated by pulling a sacrificial joint through prior to pullback

• Monitor CP current requirements and coating conductance to determine %bare area after installation
  • KEEP IN MIND; due to the depth of your designed install, can you effectively perform this step??

Highly dependent upon geological factors
SUMMARY

• HDD installations are numerous and vary greatly in type, size, and condition
• Ordinary pipeline coatings do not hold up well to HDD installations, must use special system to protect your coating (per CFR 192)
• Selection of coating is dependent upon the specific HDD project
SUMMARY

• Because coating holidays are expected, cathodic protection system has to be adequate to protect pipe and may change from job to job.
• It is critical to properly prepare and apply the field applied weld joint coating as these are a critical link in protecting your asset.
• Accurate assessment of coating condition after installation can be difficult.
• HDD installations are now commonplace and should be part of every major pipeline construction contractor’s skill set.
Questions??

Lou Taylor
NACE CIP 1; NACE PCS 2; NACE CP 1
Regional Sales Manager
Liberty Sales & Distribution
ltaylor@libertysales.net
Office: (877) 373-0118
Cell: (267) 664-8177