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# Pipeline Coating Application

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Appalachian Underground Corrosion Short Course

# Outline

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- Pipeline Coating Characteristics
- Standards for Pipe Cleanliness
- Types of Coatings
- Selecting your Coating
- Coating Detail by Product Group
- Factory vs. Field Applications
- Factory Application of FBE
- Quality Testing
- Coating Repairs



# Key Characteristics of Pipe Coatings

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- Adhesion to Steel
- Cover difficult geometry on fittings
- Environmentally Friendly
- Long lasting protection
- Above grade and below grade options needed
- Need to be compatible with other coatings
- Productive Application
- Work with Cathodic Protection . . . in many cases
- Gouge and Damage Resistance



# SSPC Standards for Cleanliness

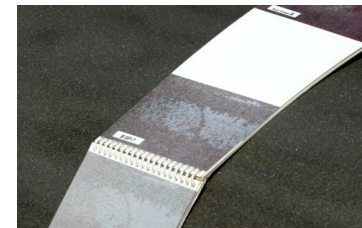
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## Common for Pipe Surface Cleaning

- SSPC-SP1 Solvent Cleaning
- SSPC-SP2 Hand Tool Cleaning
- SSPC-SP3 Power Tool Cleaning
- SSPC-SP6 Commercial Blast Cleaning
- SSPC-SP7 Brush-Off Blast Cleaning
- SSPC-SP10 Near White Metal Blast Cleaning
- SSPC-SP11 Powder Tool Cleaning to Bare Metal
- SSPC-SP12 Water Blast Cleaning
- SSPC-SP17 Abrasive Blast: non-Ferrous Metals



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# Coating Selection Criteria

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- New Pipeline, or Existing Pipeline Maintenance
- Degree of Surface Prep Available for Pipe
- If Maintenance of In-Service Pipe, what are the conditions (Moisture, Hot, Cold conditions)
- Compatibility with exiting coatings
- Above Grade/Below Grade/Transitions
- Buried Pipe or Directional Drill requirements
- Installation & Training needed
- Application Costs of the system



# Types of Coating Systems

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- Cold Applied Tapes
- Hot Applied Tapes & Mastics
- Petrolatum/Wax Coatings w/ wraps
- Heat Shrink Sleeves
- Liquid Urethane Coatings
- Coal-Tar Epoxy Coatings
- Liquid Epoxy Coatings
- Fusion Bonded Epoxy Coatings



# Cold Applied Tapes

- Material Types: Polyethylene, Butyl, Polyvinyl
- Properties:
  - Have electrical insulating properties.
  - Resistant to salt water, soil acids, common chemicals, UV weathering
  - Resistant to impact abrasions, punctures and tears
  - Variety of thicknesses are available, no special tools for application
  - Can be used for above or below grade applications
- Metal Surface Prep:
  - Surface should be clean, dry, free of oil, grease and contaminants.
  - Generally SSPC-SP1,2,3 methods used, but SP6 is beneficial.
- Application:
  - Putty/fillers can be used on irregular surfaces with fittings and valves
  - Primers generally used to promote adhesion with the tapes
  - Apply the Tapes taking special care w/ welds or non-uniform surfaces
  - Apply with spiral wrap or as recommended by the manufacturer
- Below Grade:
  - Take special care to prevent damage during backfilling





# Hot Applied Tapes

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- Material Types: Butyl & Bitumen Rubber
- Properties:
  - Good adhesion to pipe and itself
  - Resistant to cathodic Bonded
  - Easily conforms to surfaces and shapes
  - Impact resistant
  - Compatible with other coatings
- Metal Surface Prep:
  - Remove loose rust, loose particles by grit blasting or wire brush
  - Surface should be clean, dry, free of oil, grease and contaminants.
  - Generally SSPC-SP2,3 methods used, but SP6 is beneficial.
- Application:
  - Primers generally used to promote adhesion with the tapes
  - While wrapping, use a flame torch to heat the tape before it is applied.
  - After wrapping, apply heat to the outer tape surface.
  - Overlap as recommended by the manufacturer.
- Below Grade:
  - Take special care to prevent damage during backfilling





# Petrolatum/Wax Tapes

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- Material Types: Petrolatum product is generally in tape form on carrier fabric
- Properties:
  - Easy to conform to various shapes, good for cold or hot temp application
  - UV Resistant
  - Good product for wet surfaces
  - Non Solvent product
  - Not affected by salts, acids, soils
  - Available in my widths and thicknesses
  - Good for Above or Below grade applications
- Metal Surface Prep:
  - Remove loose rust, loose particles by grit blasting or wire brush
  - Generally SSPC-SP2,3 methods used, but SP12 water blasting also good.
- Application:
  - Primers generally used to promote adhesion with the tapes
  - Follow manufacturers recommendations for overlap when wrapping the pipe
  - Press out air pockets and smooth all wrap seams
  - Overwraps may be used with the wax tape for additional impact strength.
- Below Grade:
  - Take special care to prevent damage during backfilling; Overwrap may be beneficial



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# Heat Shrink Sleeves

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- Material Types: Polyolefin sheet (polyethylene or Polypropylene) Cross-linked by Heat
- Properties:
  - Designed for buried Pipe
  - Many use an Adhesive or Epoxy layer for bonding to steel and corrosion protection
  - Sleeve provides mechanical protection for abrasion and soil stress
  - Often used in conjunction with Hot Applied Tapes
  - Good chemical resistance, toughness and flexibility
  - Often top coated for with ARO liquid products
- Metal Surface Prep:
  - SSPC SP-2 (hand tool), SP-3 (mech tool), SP-6 (commercial)
- Application:
  - Typically used in buried pipe applications
  - Girthwelds or Damage repairs areas
- Repairs:
  - Either Replace or repair with Various Tape options



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# Liquid Polyurethane Coatings

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- Material Types: Most are polyisocyanate systems including polyols and polyamines
- Properties:
  - Used for Buried pipe or above grade applications
  - Can be applied to steel or as a UV protective topcoat
  - Good flexibility and impact resistance
  - Works well in colder temp applications
  - Good adhesion, typically not to the level of most liquid epoxy
  - Compatible with CP systems, like epoxy
- Metal Surface Prep:
  - SSPC SP-10 usually recommended
- Application:
  - Buried or above grade applications
  - Applied via Brush or Plural Spray
- Repairs:
  - Repair with compatible Urethane coatings following Mfg instructions



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# Coal-Tar Epoxy Coatings

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- **Material Types:** Generally a 2-part polyamide system. Used on Steel or Concrete surfaces.
- **Properties:**
  - Brush or spray applied
  - Good resistance to water, wastewater, and seawater
  - Good abrasion, impact, adhesion and hardness characteristics
  - Generally used directly to steel, no primer
  - High build up to 25 mils
  - Generally has different adhesion prep requirements for immersion or non immersion use
  - Used in non-potable applications with piling, sheet piles, lock gates, reservoirs, bridges, etc.
- **Metal Surface Prep:**
  - Remove oil, grease, dust and other contaminants.
  - Generally SSPC-SP3,6 methods used for non-water applications
  - SSPC-SP10 recommended with min 2 mil profile for immersion applications,
  - Follow manufacturer's recommendations for concrete applications
- **Application:**
  - Product is applied directly to steel surface by brush or single part spray application
  - Prevent sag by staying within manufacturers recommended max build level.
  - Use wet gauge to verify coating thickness vs. spec
- **Repairs:**
  - Areas to be repaired can typically be abraded with by hand with sandpaper or SP-2,3 level cleaning.



# Liquid Epoxy Coatings

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- Material Types: 100% Solids, No VOCs, 2-Part Coatings
- Properties:
  - Used as Single or Dual layer coating; Used over FBE or directly to steel.
  - Multiple uses . . . Repairs, Girthwelds, Fittings, Valves, Bends, etc
  - Wide Ranges of Gel Times
  - Excellent adhesions & high abrasion resistance;
  - Can achieve high build in a single application with minimal sag. (50 mils+)
  - Variety of delivery systems for brush/roller, spray gun and plural spray applications
  - Generally non-shield for work with CP systems;
- Metal Surface Prep:
  - Large Areas: Metal blast to SSPC SP-10 with 1.5-4.0 mil profile
  - Small Areas: SSPC SP-2 or 3 Cleaning
- Application:
  - Brush, High Solid Spray, or Plural Spray Options
  - Product and Application training typically required by the manufacturer.
- Repairs:
  - Small Areas SP-2,3 level cleaning.



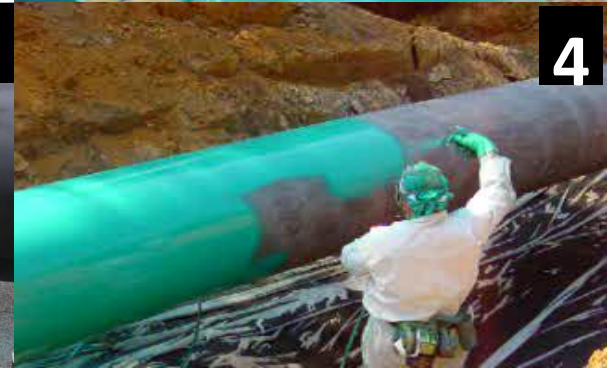
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# Liquid Epoxy Application Methods

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1. Manual Application (Brush & Roller)
2. Manual Cartridge Dispensing (Brush & Roller)
3. High Solids Spray Cartridge Application
4. Plural Component Application





# Liquid Epoxy Quality Control

## Record all Pipe Data & Keep for your Records

- RH, Dew Point, Temperature
- Blast Profile
- Backside Contamination
- Wet Film Thickness (Wet)
- Dry Film Thickness (Dry)
  - *Magnetic Guide*
- Hardness
  - Durometer – measuring Shore D Hardness
- Holiday Detection



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# Recoat Window – Liquid Epoxy

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- Recoat Window – Important for Liquid Coatings
- The Re-Coating Windows will vary
- Most Liquid Epoxy can be Re-Coated while they are still Tacky
- Hot, Dry conditions reduce the Re-Coat Window;
- Lower temps and higher humidity increase the window.
- After coating dries, must abrade the surface to Recoat
- *Follow all Manufacturer's Instruction when Re-Coating.*

## Air Temp Recoat Window\*

60°F	4-6 hours
75°F	3-4 hours
85°F	2-3 hours
100°F	1-2 hours

\*Variable by Product (example only)



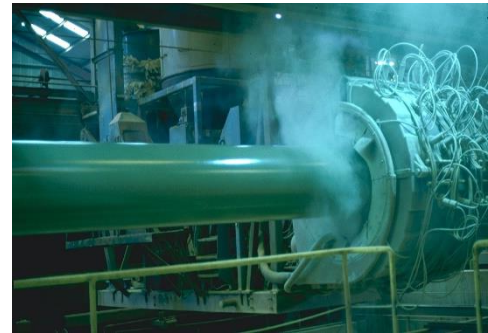
# Fusion Bonded Epoxy Coatings

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- Material Types: One part, heat-cured thermosetting Resins.
- Properties:
  - Mostly Factory Applied
  - Single Layer or Dual Layer Coatings
  - High-volume, low-cost Installations
  - Environmentally Friendly
  - Excellent adhesion & Abrasion Resistance
  - Generally non-shield for work with CP systems
  - Easy to Repair, but can be damage
  - Compatible with Liquid Epoxies
- Metal Surface Prep:
  - SSPC SP-10 Near White Metal: 2.0-4.0 mil profile
- Application:
  - Requires significant Investment to apply
  - Spray, Fluid Bed Dip
  - Some Products/Applications require Post Cure Process
- Repairs:
  - Liquid Epoxy used



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# Field vs Factory Applied

Coating Systems	Factory	Field	Notes
Cold Applied Tapes		<b>1</b>	<i>Generally Used for Repairs; easy to apply</i>
Hot Tapes/Mastics		<b>1</b>	<i>Generally Used for Repairs</i>
Petrolatum/Wax Coatings		<b>1</b>	<i>Great for Repairs/Transitions</i>
Heat Shrink Sleeves		<b>1</b>	<i>Girthwelds and Damage areas</i>
Urethane Coatings	2	<b>1</b>	<i>Flexible for both Field &amp; Factory</i>
Coal Tar Epoxy Coatings	<b>1</b>	2	<i>Better to Apply in Controlled Env.</i>
Liquid Epoxy Coatings	2	<b>1</b>	<i>Flexible for both Field &amp; Factory</i>
FBE Powder Coatings	<b>1</b>	2	<i>Investment required to apply</i>

**1** Primary Use

**2** Secondary Use



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# FBE Powder Application Types

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## Factory Applications:

- Line Pipe Applications
  - Semi-Automated, continuous process on 40' to 80' pipe lengths
  - Highly efficient on large projects
- Custom Coating Applications
  - Manual Application methods for parts or smaller volumes
  - Spray, Fluid Bed Dip, or Electrostatic application to parts

## Field Applied Powders:

- Girthweld Coating
  - Applied at the right-of-way during pipe installation
  - Requires heat source and powder spray equipment in the field

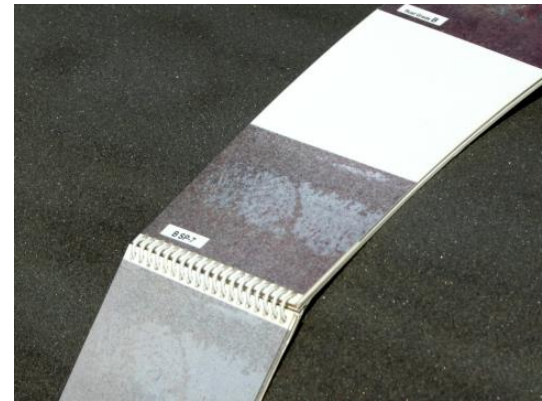


# Steel Prep & Testing for FBE Application

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## Quality Test Documentation:

1. SSPC SP-10 Near White Metal Finish
2. Backside Contamination Level: < 20% (SSPC Guide)
3. Chlorides Test – Pass
4. Sulfides Test – Pass
5. Steel Profile 2.0-4.0 mil profile
6. Grinding to remove burrs, < 1%
7. Phosphoric Acid Wash (during application)

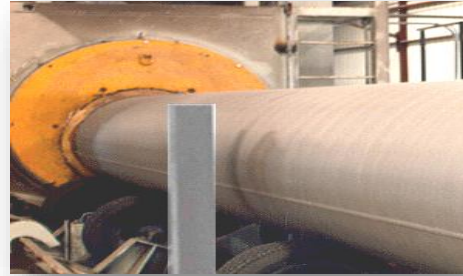


# Line Pipe FBE Application Steps

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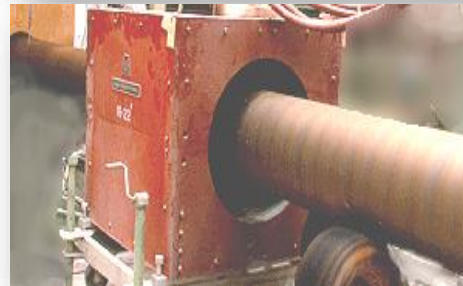
## 1. Cleaning Process

- Preheating/cleaning
- **Shot/Grit Blasting**
- Grinding
- Testing
- Acid Washing



## 2. Heating Process

- Induction or Gas Heat
- 438 – 475 deg F



## 3. Spray Booth

- Electrostatics
- Gun set-up
- Single or Dual Coat



# Line Pipe FBE Application Steps

## 4. Cure

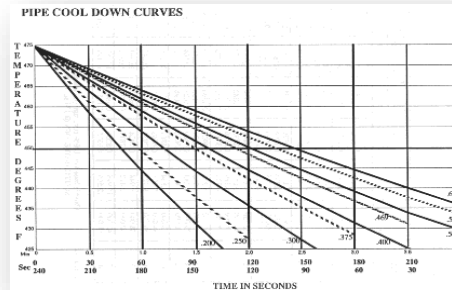
- Line Speed
- Pipe Wall Th.
- Data Sheet

## 5. Quench

- Line Speed
- Handling

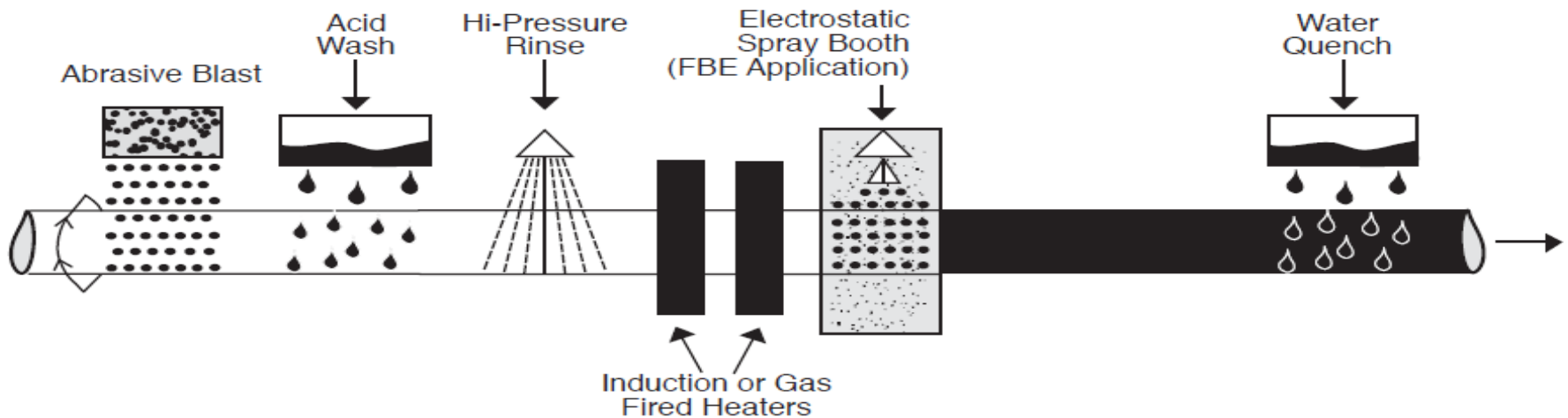
## 6. Inspect / Repair

- Coating Thickness
- Holidays
- Surface Defect

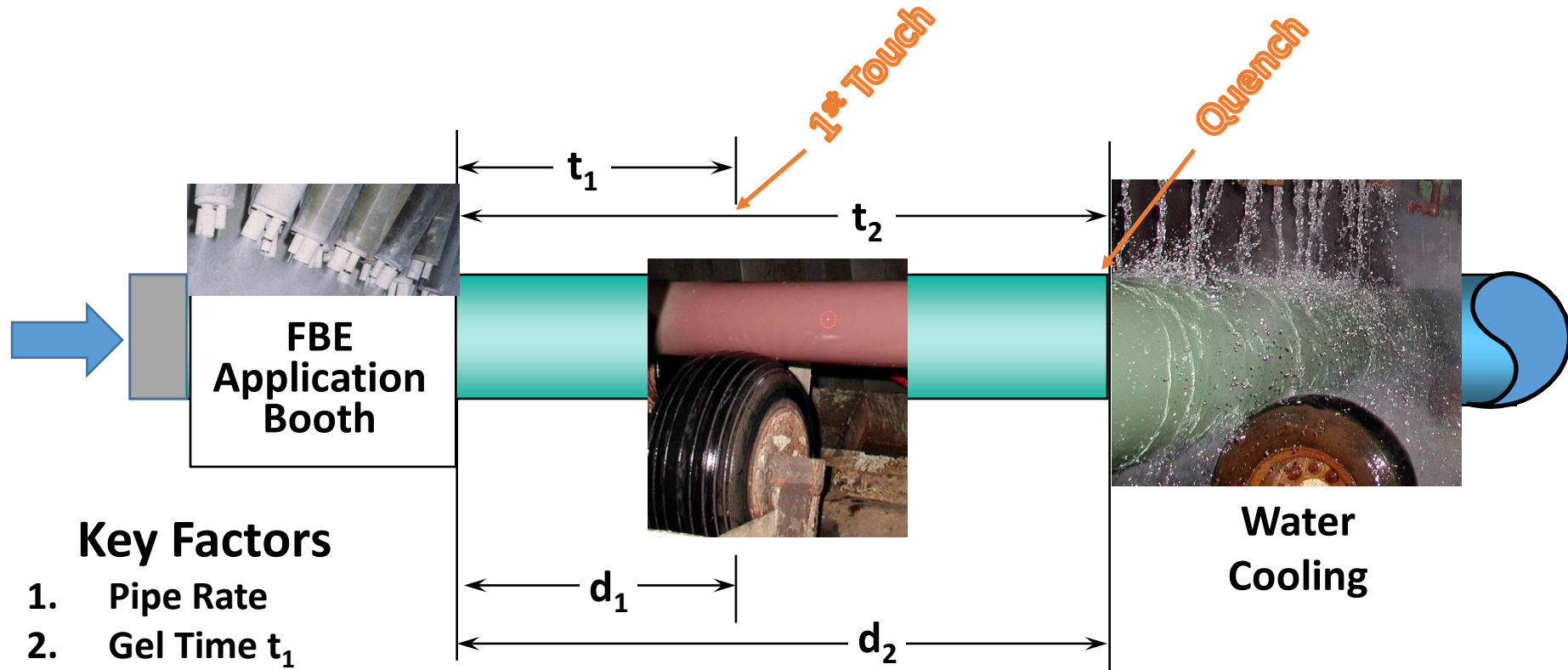




# FBE Application Process



# FBE Cure & Quench Process



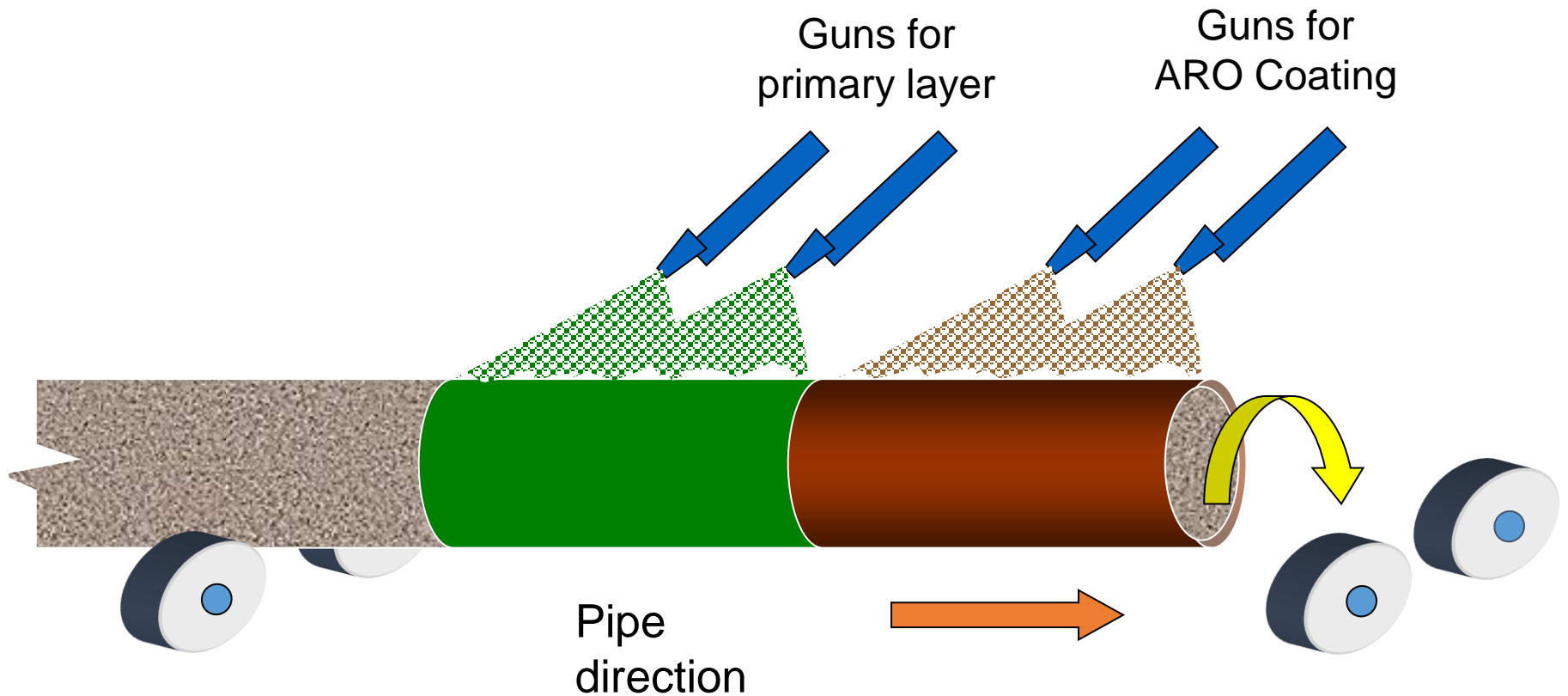
## Key Factors

1. Pipe Rate
2. Gel Time  $t_1$
3. Quench Time  $t_2$

$$\text{Rate} = \text{Time} / \text{Distance}$$

$t_1$	=	Time to Gel (Seconds)
$t_2$	=	Time to Quench (Seconds)
$d_1$	=	Distance to First Touch
$d_2$	=	Distance to Quench

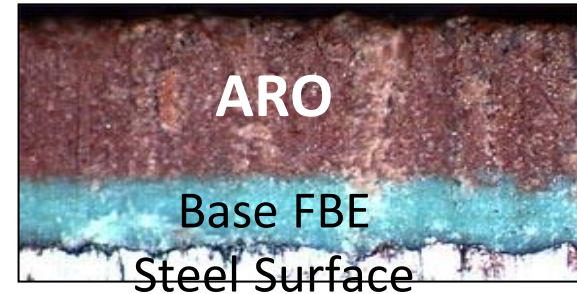
# Dual Layer ARO Coating Process



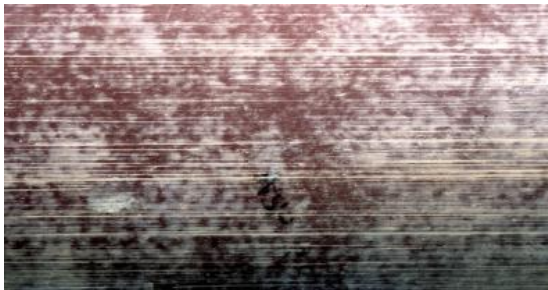
# Abrasion Resistant Overcoat (ARO)

## ARO Layer Provides:

- Damage Protection
- Gouge Resistance
- Impact Resistance



Directional Drill Damage



Transportation Damage



Backhoe Damage



# Line Pipe Girthweld Cut Backs

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## Cut Back Requirements for Line Pipe:

- Pipe is Coupled as is passes through the process to maintain consistent heat on the pipe ends.
- Cutbacks created by . . .
  - Taping off the Pipe (tape removed after coating)
  - Or with Special Coupling Forms
- Cut Back's typically vary from 2"-6"
- Cut Back is later Field Coated



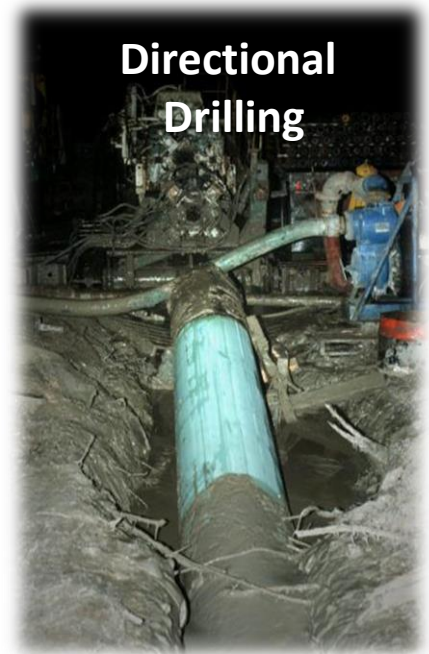


# FBE Field Coating of Girthwelds

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# Directional Drills

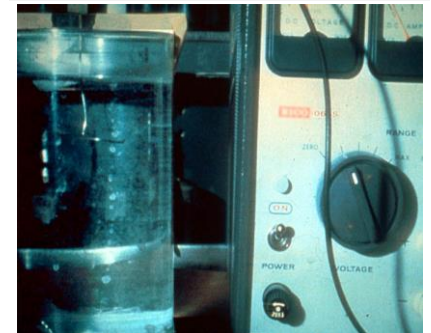
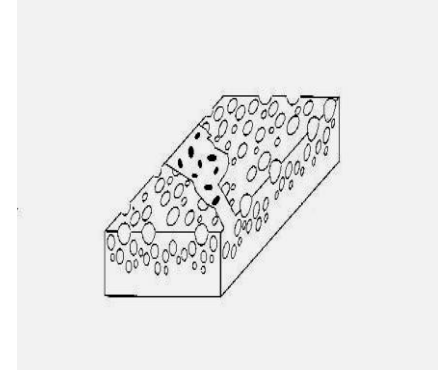




# Quality Control Testing

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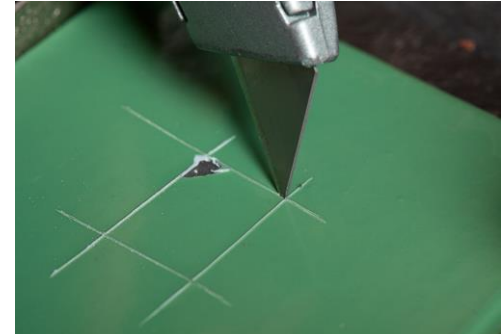
- DSC – Cure
- Adhesion
- Bend/Flexibility
- Impact
- Porosity
- Cathodic Disbondment
- Hot-water adhesion
- Gouge Testing



# Testing of Applied Coatings

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- Cathodic Disbondment
- Hot Water Adhesion
- Impact Testing
- Flexibility
- DSC – Cure
- Porosity



# Repair Guidelines: Small v. Large

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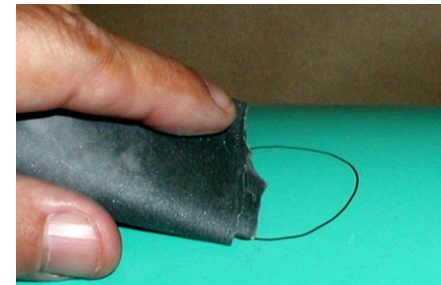
1. Smaller Repairs\*:      < 16 inch<sup>2</sup>
  - Allow for Sanding or Mechanical Tool
  - Follow all Specs
  
2. Larger Repairs\*:      16 inch<sup>2</sup> or Larger
  - Requires Grit Blasting
  - Follow all Specs

# Epoxy Coating Repairs

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1. Holiday Repairs:  $\leq 4\text{mm}$  holidays
  - 2-Part Epoxy or Patch Sticks generally used
2. Smaller Repairs: Less than  $16\text{ inch}^2$ 
  - 2-Part Epoxy generally Specified
  - Less than a full blast may be allowed for this repair
3. Larger Repairs:  $16\text{ inch}^2$  or Greater
  - 2-Part Epoxy Specified w/ full abrasive blasting

*Follow the End User Specification & Manufacturer's instructions*



# In Summary

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- Select the right product for your job
- Know the required Cleanliness level
- Make sure your Installers are Trained
- Follow End User specs and manufacturer guidelines
- Thoroughly document your coating installation
- Following Testing requirements
- Repair Defects
- Follow Safety Guidelines

