



AUCSC

Appalachian Underground Corrosion Short Course

Critical Application Steps with Two-Part Epoxies

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Agenda



- **Product Overview**
- **Storage**
- **Safety**
- **Surface Preparation**
- **Mixing**
- **Application**
- **Quality Control**
- **Epoxies and HDD Applications**

Product Overview



High Build Epoxies

- **185° to 205° Operating Temperature**
- **100% Solids (no solvents)**
- **2 component system (3 parts base / 1 part cure)**
- **Used for girth weld protection, valves & fittings and repair**
- **Supplied in Brush Grade Kits (liters or pounds), Spray Grade Material and Cartridge Guns (repairs)**
- **Various cure rates available**

Storage



- **Product should be stored at temperatures between 40°F and 105°F**
- **Do not store epoxy in direct sunlight on ROW**
- **DO NOT ALLOW to FREEZE**
- **Shelf life of 2-3 years when stored as specified**
- **Must ALWAYS check shelf life dates prior to application**

Safety



READ MSDS sheet

Applicators should wear a mask with the proper cartridge (NIOSH Approved) to protect against the amine (cure side) vapors in high preheat and spray applications



Small percentage of the population are allergic to the amine vapors and other materials in 2PE. (rash)

Wear splash proof chemical safety glasses and rubber gloves during installation

Spilled cure or material remaining in cure containers can be neutralized by mixing with base material



Keys to a Successful Epoxy Installation:

- **Proper Surface Preparation – Critical**
- **Understanding the role of Temperatures - Critical**
 - Material Temperature
 - Surface Temperature
 - Ambient Temperature

Surface Preparation



Primary objective of surface preparation is to provide maximum coating adhesion

Proper Surface Preparation will:

1. Remove any loose/rust material from the surface
2. Increase the surface area
3. Impart an anchor pattern

Surface Preparation - Moisture Removal



- **Remove moisture before sandblasting.**
- **Flash Rust – when blasted surface has been exposed to water or vapor (rain, dew point, high humidity)**
 - To avoid flash rusting do not reheat the surface after blasting. (<105°F)
- **Examples of heat sources are infra-red heaters, induction coils or propane torches.**

Induction Coil Preheat

- Uniform heating across width & around circumference of joint
- Controlled & repeatable heating process
- Penetrating heat for lasting effect
- Imparts no surface residues
- Quicker heating times
- Extensive track record on thousands of projects



Propane Torch Preheat



No weed burners

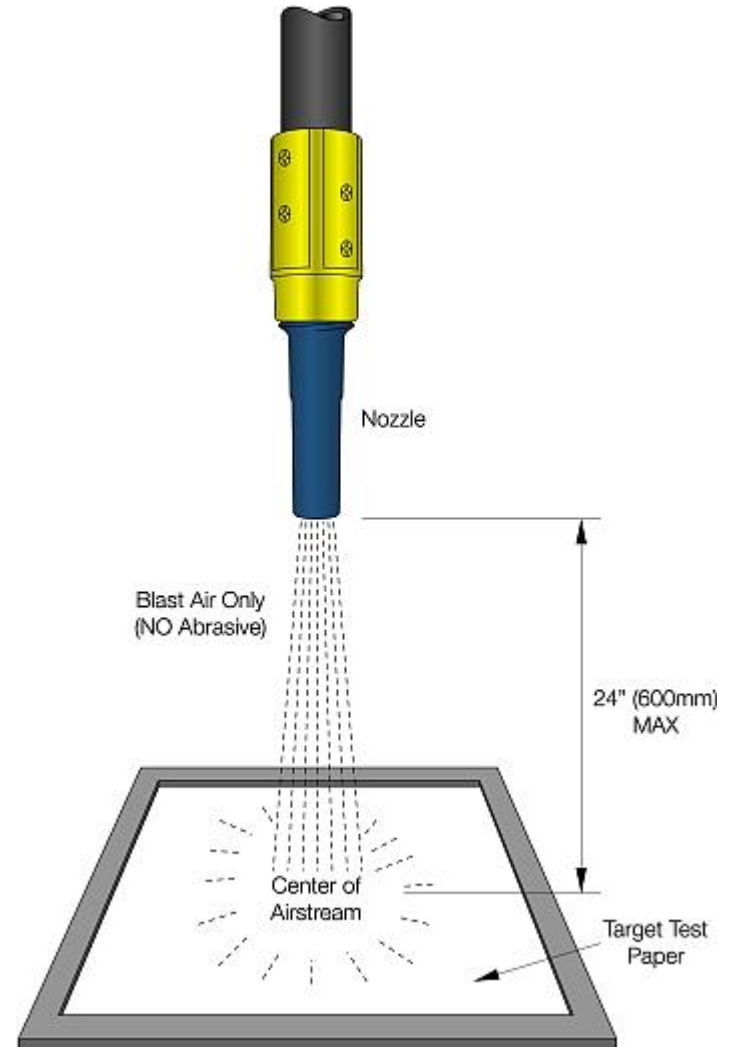
Surface Preparation



Air Compressor Blotter Test



- **ASTM D 4285**
- **White, absorbent paper placed on a hard surface**
- **Run for 1 minute – look for moisture / oil**
- **Done once per shift**



Surface Preparation



- **Most 2PE require an abrasive blast surface to Near-White Metal (SSPC-SP10, NACE 2, Sa 2 ½) or better.**
- **Blast profile should be 2.5 - 5 mils**



Near-White Surface Prep



Testex Tape w/ micrometer

Surface Preparation



NACE 2 / SSPC SP10

2.5 - 5 mil anchor profile

No visible contaminants, mil scale, rust, oxides, coating, etc.

Random staining limited to no more than 5% of each unit area (3" x 3")

Random staining may consist of light shadows slight streaks, minor discolorations.

Surface Preparation



A number of products will result in a 2.5 - 5 mil sharp angular anchor profile:

G-25 Steel Grit

16 Grit Aluminum Oxide

Black Beauty 1240

EnviroGrit – recycled glass

**PLAY SAND IS NOT
ACCEPTABLE!**

**Contains contaminants & silica
Silicosis = “No Bueno”**

Certified Grit

**Sieve tested, no oil or
hydrocarbon contamination**

Surface Preparation



“Little Bully” Blaster



Surface Preparation



Power tool cleaning with wire brush (SSPC SP3) **NOT ACCEPTABLE**



Use of MBX Metal Blaster is acceptable, imparts 2.5 – 3 mil profile

Surface Preparation Comparison



Power wire brush (SP3) vs. Near white metal surface prep (SP10)

- **Significant decrease in adhesion, impact resistance, CD values and rust creepage.**
- **Reference: "Evaluation of various power tooling methods for surface treatment of protective coatings." - Corrosion 2005, NACE International.**

Surface Preparation



- **Mainline coating must be cleaned and abraded.**
- **Knock shine off existing coating**
- **Don't blast through existing coating.**



Surface Preparation – Ambient Conditions



- **Substrate Temperature 50° – 200°F**
- **Substrate Temperature 5°F above the Dew Point**
- **Relative Humidity <85%**

Mixing Two Part Epoxies



- **Most two part epoxies are supplied in two separate containers:**
 - Large Container – Base
 - Small Container - Cure
- **Containers will be color coded to prevent mixing different kit sizes**



Mixing Two Part Epoxies



- **Empty all cure from container to ensure proper 3:1 ratio is achieved.**
- **The use of a paint stick or rubber spatula can help you to remove all cure contents**



Neutralize cure container by mixing in base material

Mixing Two Part Epoxies



Mixing Choices:

- Hand
- Mechanical Mixer (Drill)
- Pneumatic Dispenser
- Plural Component Spray
- Plural Component Dispenser

Mixing Two Part Epoxies



By Hand

- Use a **clean**, sturdy stirring stick
- Make sure to mix material on the sides and bottom
- Approximate Mixing Time: 4 minutes



Mixing Two Part Epoxies



Mechanical Mixer

- **Use a clean mixer**
- **Ensure that the mixer is neither too large or too small.**
 - Too large and it will whip in a lot of air into the epoxy
 - too small and it may take too long to mix or it may not mix the epoxy fully
- **Watch the speed of the drill, if you have too high of a speed it will cause a vortex to form in the epoxy which will beat air into the epoxy. The use of a variable speed drill is essential.**
- **Sides and bottom**
- **Metal mixing paddles**
- **Approximate Mixing Time: 1 minute**



Mixing Two Part Epoxies



- **Be sure to mix all of the materials together. Ensure that you reach the bottom corners of the pail and to scrape the material off the wall of the container.**
- **Most 2PE have a white base and dark cure. A properly mixed batch will result in a homogeneous color with no streaks**
- **Neutralize the cure containers**
- **Larger kits = more volume = less pot life**

Mixing Two Part Epoxies



- **Do not mix epoxy on top of the pipe. Straight cure is corrosive and any spilled material will need to be properly removed from the pipe.**

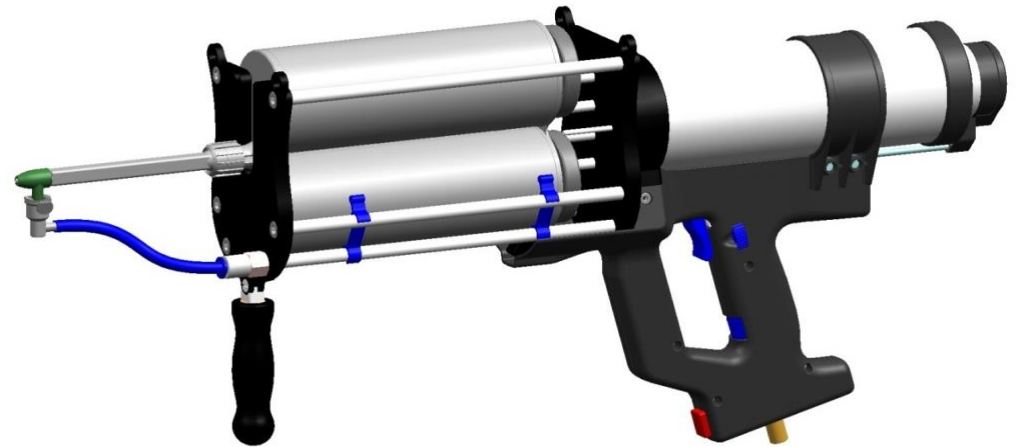
Do Not Allow “Road-Side” Chemistry!

- **Cure heavy - will react too quickly and become brittle once it has kicked over**
- **Cure light - may never react fully and will not provide proper corrosion protection**

Epoxy Application: Pneumatic Spray



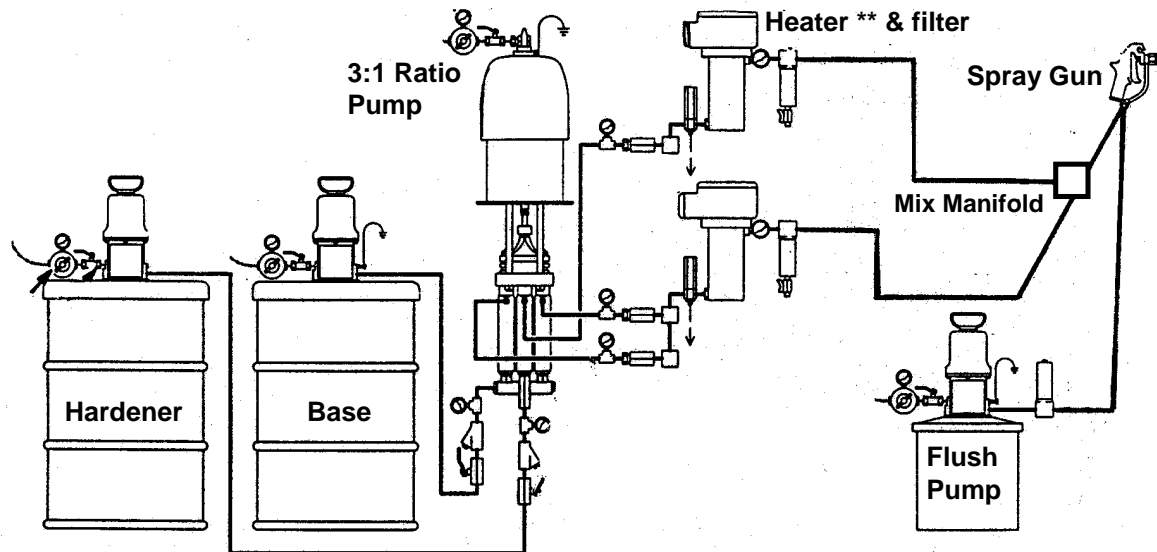
- **1.0 liter cartridges**
- **90 second application**
- **Automated Mixing**
- **Zero waste in pails**
- **Material preheat is critical**



Epoxy Application: Plural Component Spray



Typical Plural Component Spray Equipment



Other items (not identified) include hoses, filters, pressure regulators and gauges

** Minimum two 2.5kW heaters on Base-side and one 2.5kW on Hardener-side

Epoxy Application: Plural Component Spray



Mixing Two Part Epoxies Dispensing Equipment



- **Pneumatic dispenser provides the following key benefits:**
 - **Precise volumes dispensed per joint**
 - **Eliminates hand mixing time / errors**
 - **Eliminates component container waste**



Epoxy Application: Automated Liquid Application



CRC-Evans PIH technicians specialize in a wide range of field joint coating systems, often working with large-diameter pipe spanning diverse terrains and climates.

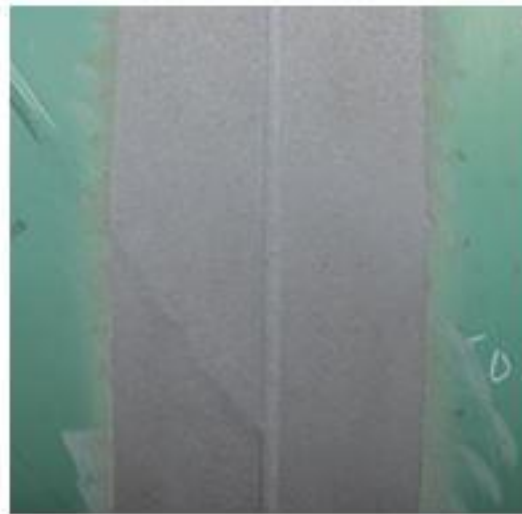
Semi-Automated Epoxy Application



Epoxy Application: Automated Liquid Application



Pre-heat – Induction Coil and Generator
Surface Prep – Automated Grit Blast
Application – Automated Epoxy Application





How fast does the epoxy set up???

Temperature and Epoxy Application



**Numerous liquid coating systems on the market:
standard cure, fast cure, cold weather cure, moisture
tolerant, etc.**

**Must be aware of all temperatures and the relationship
to cure times:**

- Material Temperature**
- Pipe Temperature**
- Ambient Temperature

Temperature Effects On Application



Material Temperatures

(determines pot life)

- **Warm / Hot Material**

- Can dramatically reduce the pot life
- 5° to 10°F increase in material temp = 50% decrease in pot life

- **Cool / Cold Material**

- Will be difficult to mix
- Difficult to obtain a proper blend
- Will be thicker and harder to spread

- **Larger kits = more volume = shorter pot life**



Pipe Temperatures (determines cure time)

- **Surface temperature is too hot:**
 - Epoxy may become runny and difficult to build thickness
 - Epoxy sets up too quickly leading to streaks, clumps, icicles
- **Pipe surface temperature is too cool:**
 - Epoxy may not wet out fully into the steel and could affect adhesion
 - Epoxy may be hard to spread out leading to an extra thick coating that is out of spec and wasted material

Temperature Effects On Application



- **Do not stage epoxy on top of the pipe that has been sitting in the sun. Heat from the pipe transfers to the material containers which accelerates the cure.**



Ambient Temperatures

(affects material & surface temps)

- **Warm / Hot Weather**
 - Speed up pot life and cure times
- **Cool / Cold Weather**
 - At 50°F most epoxies cure very slow
 - Recoat project example: Cold ambient / warm material temp / 55F pipe temp

Epoxy Application



Thixotropy - time dependent shear thinning property

Materials that are thick or viscous under static conditions will flow (become thin, less viscous) over time when shaken, agitated, sheared or otherwise stressed (time dependent viscosity).

Epoxies – allows the installer to build thickness over the welds, prevents drips, runs and icicles at the bottom of the pipe

Temperature Effects On Application



Cold ambient temperatures do not limit epoxy applications.



Increased substrate temperatures = faster cures

Should this be done??

Surface Prep - Temperature



Pipe Temperatures

- **Faster cures can be achieved by pre-heating the steel pipe surface.**
 - If you are pre-heating with a propane torch, preheat should be done before grit blasting
 - If you plan on heating after the blast, ensure that the steel is over 40°C (105°F) or you will get flash rust.
- **Each manufacturer will have a target pre-heat temperatures.**
- **Excessive preheat (off-gassing of solvents) which can lead to pinholes in coating**



Pipe, material and ambient temperatures are always changing on the ROW and you need to make adjustments!

Other Application Issues



- **Hydrostatic testing to verify pipe integrity**
 - If you exceed 100% or more of the specified minimum yield strength (SMYS), you can exceed the flexibility of the coating resulting in cracks.
 - Check tensile and elongation of the two part epoxy.
- **Flexibility on bore applications**
- **Be aware of coatings thickness – too thick can result in cracking**



QUALITY CONTROL

QUALITY CONTROL



SSPC VIS-1 surface prep comparison chart

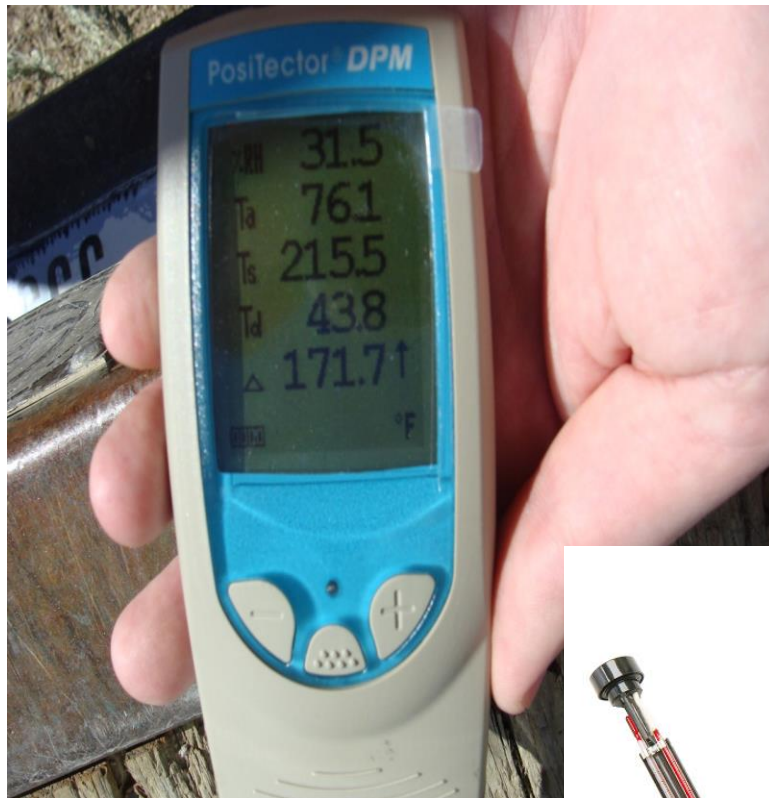


Near white metal surface prep

QUALITY CONTROL



PosiTector DPM (Dew Point Meter)



- Ambient Temperature
- Surface Temperature
- Dew Point $> 3^{\circ}\text{C}$ (5°F) above the dew point.

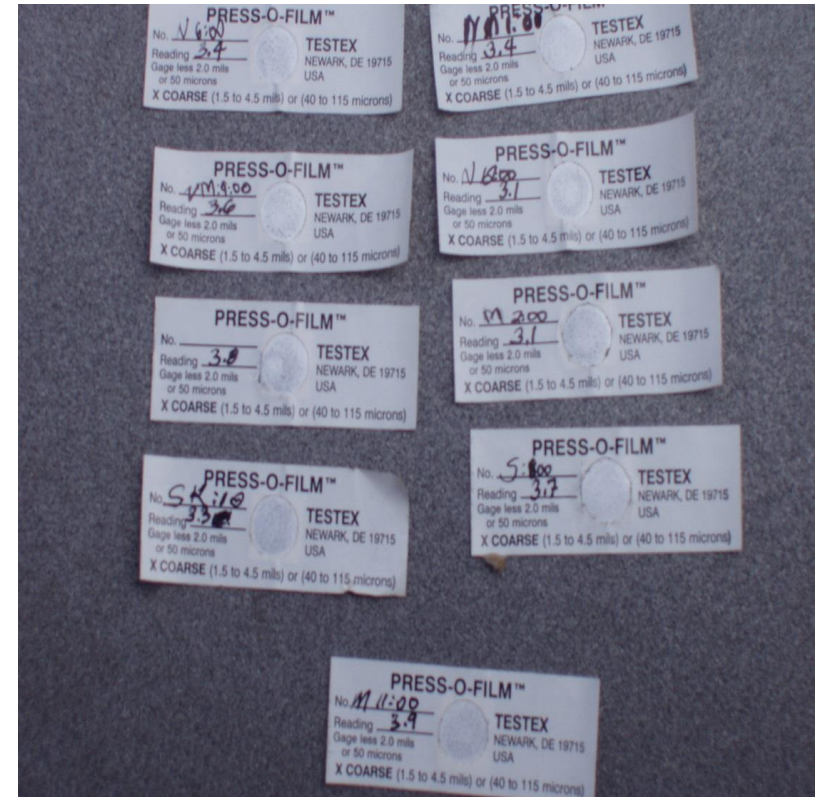


Sling Hygrometer

QC – Surface Prep



Measuring Surface Profile – Testex Tape (multiple locations!)



QC – Surface Prep



Elcometer – Measure & Record Blast Profile



Usually every 25th weld

3 readings in random quadrants

Any changes to the equipment,
operator or media

2.5 – 5 mils

QUALITY CONTROL



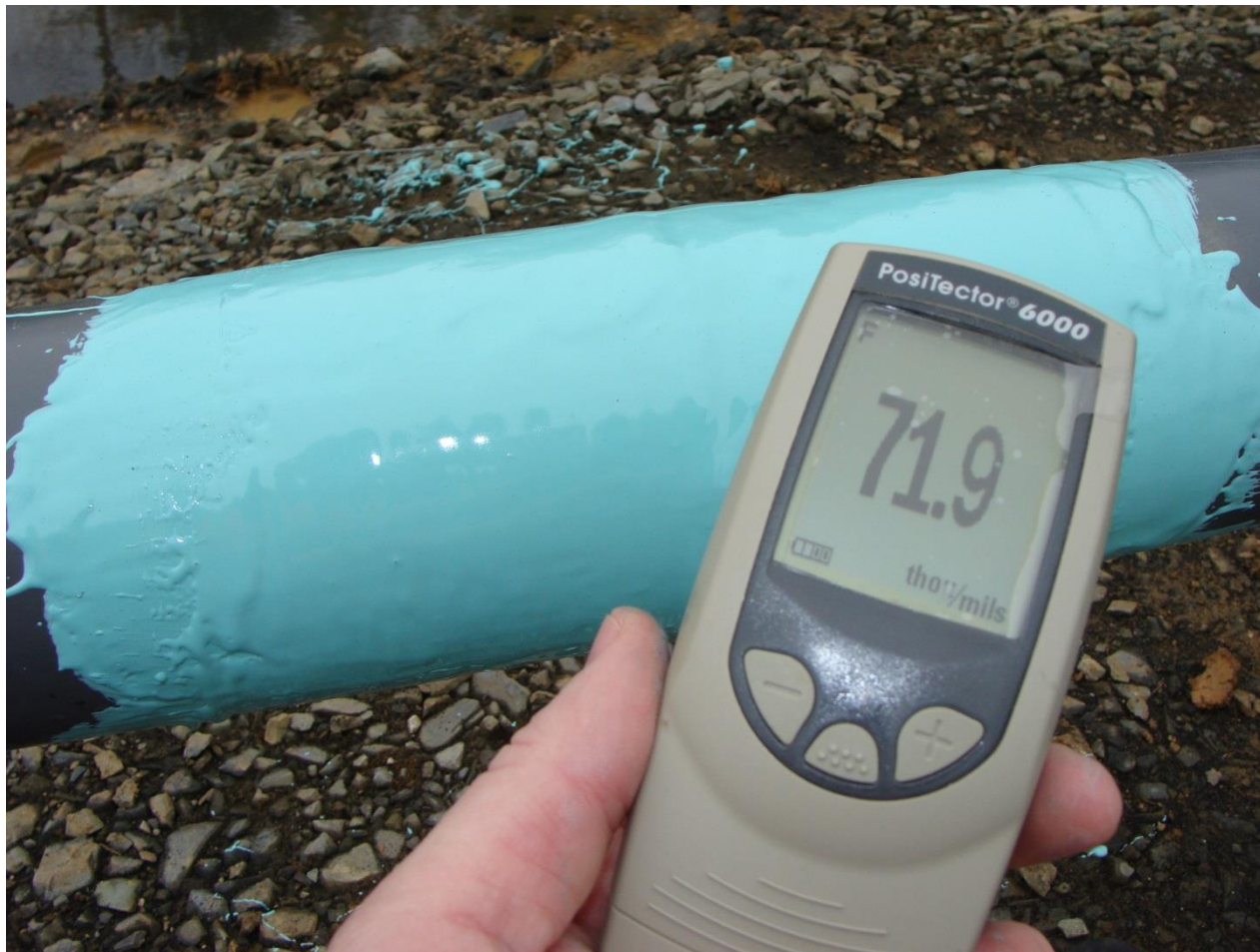
Measuring Wet Film Thickness



QUALITY CONTROL



PosiTector – Measuring DFT



QUALITY CONTROL



Durometer – Measuring Shore D Hardness



- Tests the epoxy for % of cure
- Can be used to determine if the coating is hard enough for backfill (>70 Shore D)
- Needle sticks out 100 mils @ 0 Shore D
- At 100 Shore D, needle sticks out 0 mils
- Can cause jeeps if the coating is too thin to measure.

- Make sure that coating is thicker than expected penetration (>60 mils, "button" @ 12 o'clock over existing ML coating)
- "Button" temperature (50°F – 77°F)

- Shore D = 70-80
- 20 mil coating is not cured
- Needle penetrates coating, hits steel = Shore D of 80

Quality Control

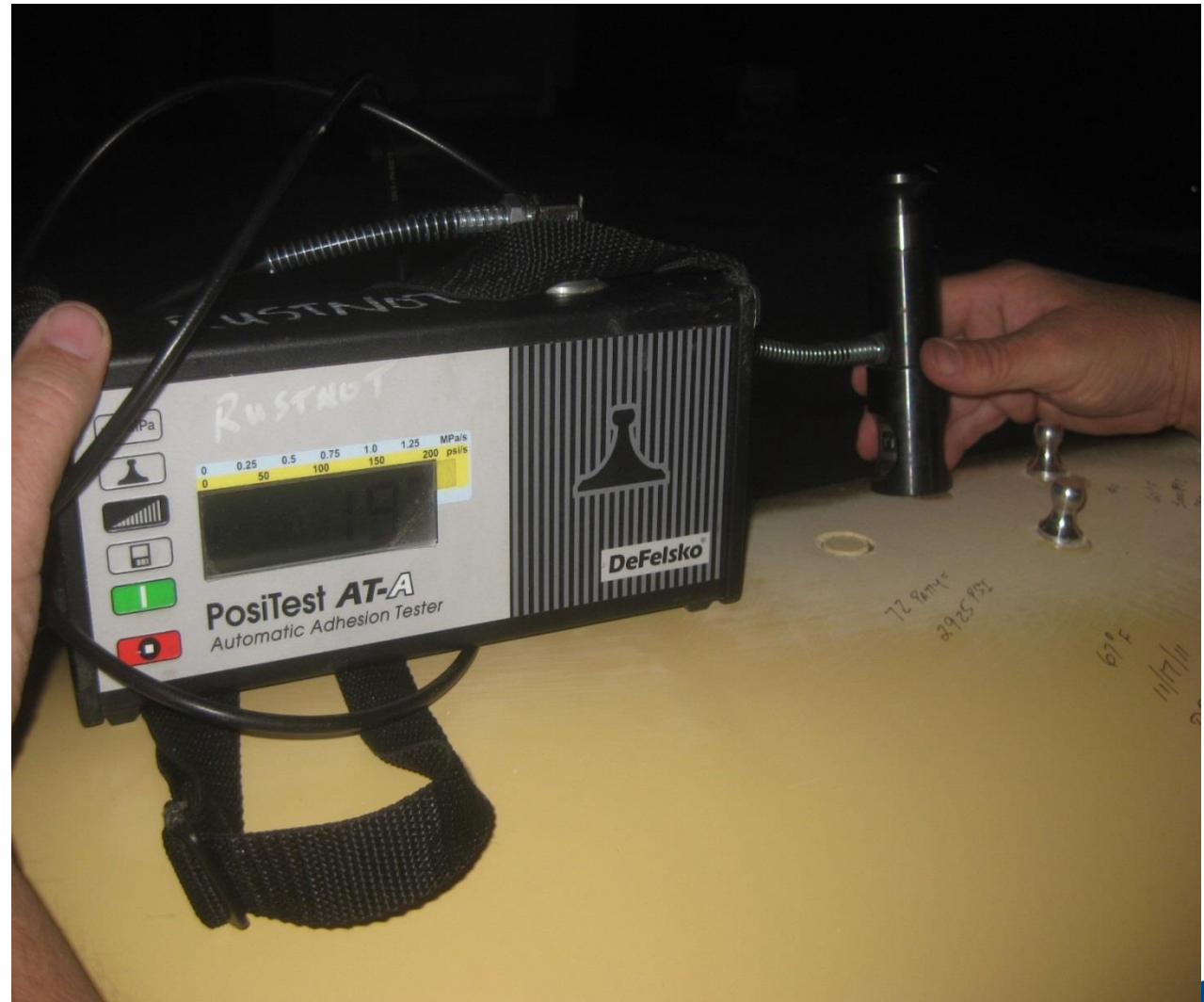


Adhesion
Testing

DeFelsko
PosiTest

Typical Values
2,000 – 3,000
PSI

Lengthy Test –
24 hours for
dolly glue to
cure



Quality Control



Adhesion Tester

Dollies &
Cutting Tool



Quality Control



Holiday Detection (3)

SP0 490

FBE ML coatings

125V/mil

NACE SP 0188

< 20 mils wet sponge

21-40 mils = 3K

41-55 mils = 4K

56-80 mils = 6K

NACE RP 0274

$$V = K\sqrt{T}$$

Where:

K = 1250

T = coating thickness in mils

Higher Voltages

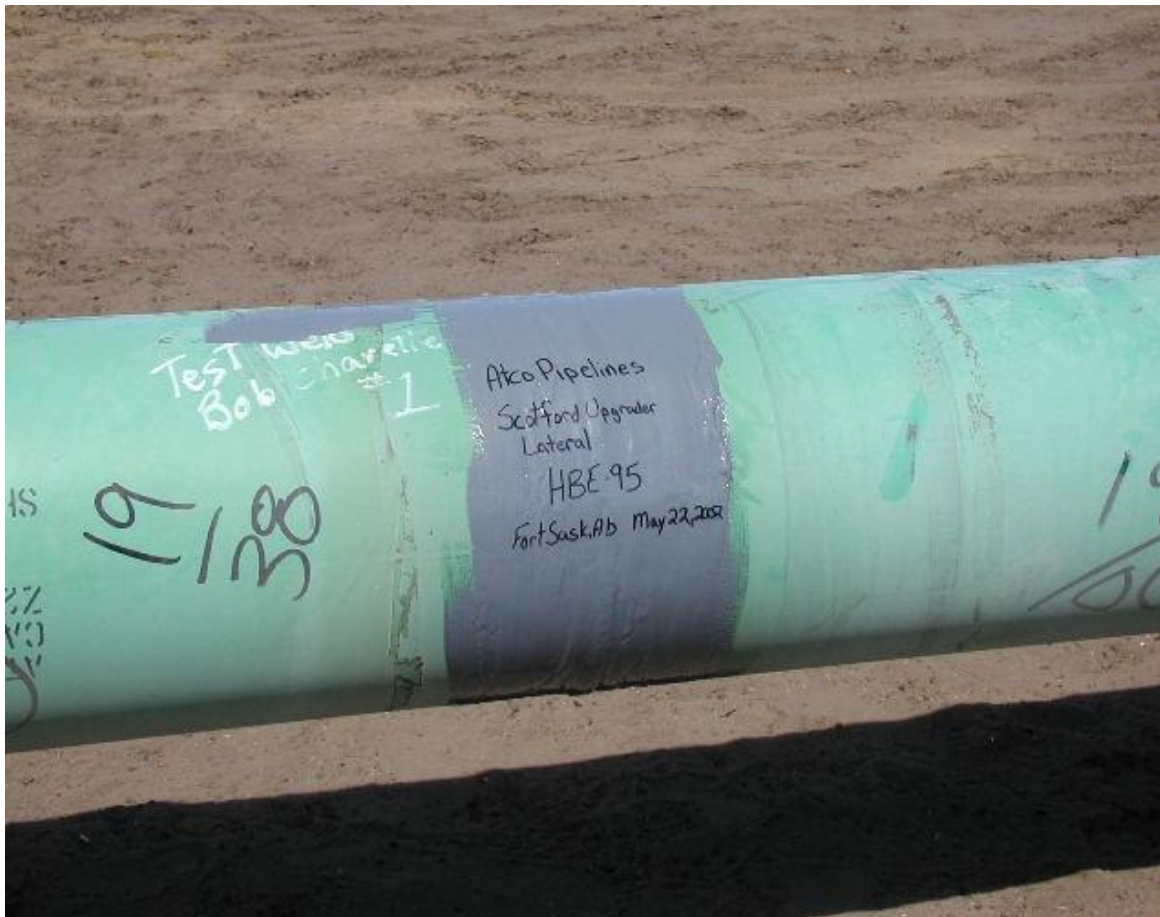


SP 0188 @ 30 mils = 3K / RP 0274 @ 30 mils = 7K Volts **Watch ML coating**

Coating Logs



Installers need to take ownership of the application





Cold Weather Question

Coating Logs



- **Date & Time**
- **Girth weld number or location description**
- **Coating brand / Model number**
- **Batch Information (QC Number) Expiration Date**
- **Pre-Heat Temp**
- **Blast Media Used**
- **Anchor Profile**
- **Substrate Temp**
- **Ambient Temp**
- **Dew Point**
- **Max / Min dry film coating thickness reading**
- **Name of installer(s)**
- **Digital pictures**

Applicator / Inspector Training

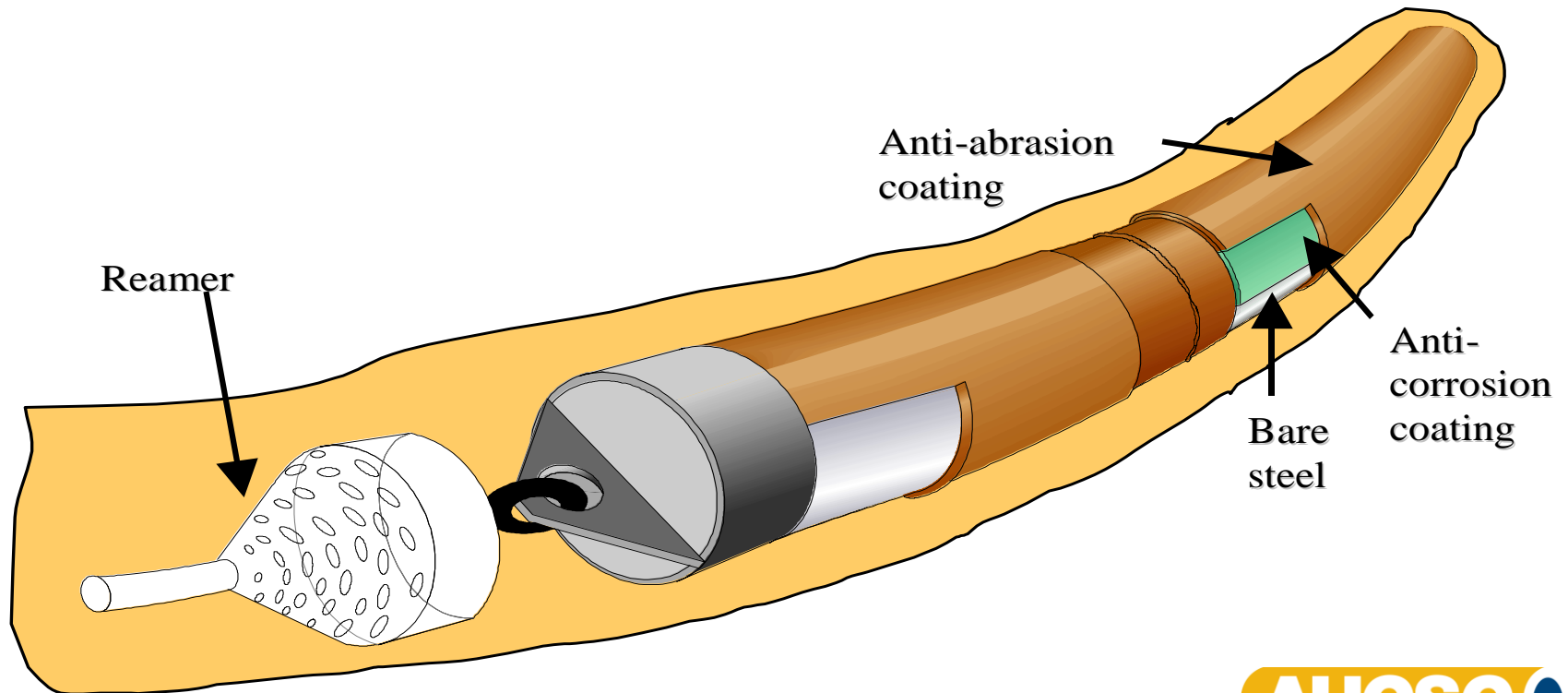


Coatings are only as good as the installation.

- Install Guides
- Install Videos
- On-site tech support
- Applicator Certification
 - Applicators must have the knowledge, skills and ability to apply the product



Epoxy FJC / HDD Installations



Federal Guidelines for PL Coatings



§ 192.461. External Protective Coatings

(a) Each external protective coating, whether conductive or insulating, applied for the purpose of external corrosion control must -

- (1) Be applied on a properly prepared surface;
- (2) Have sufficient adhesion to the metal surface to effectively resist under film migration of moisture;
- (3) Be sufficiently ductile to resist cracking;
- (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.**

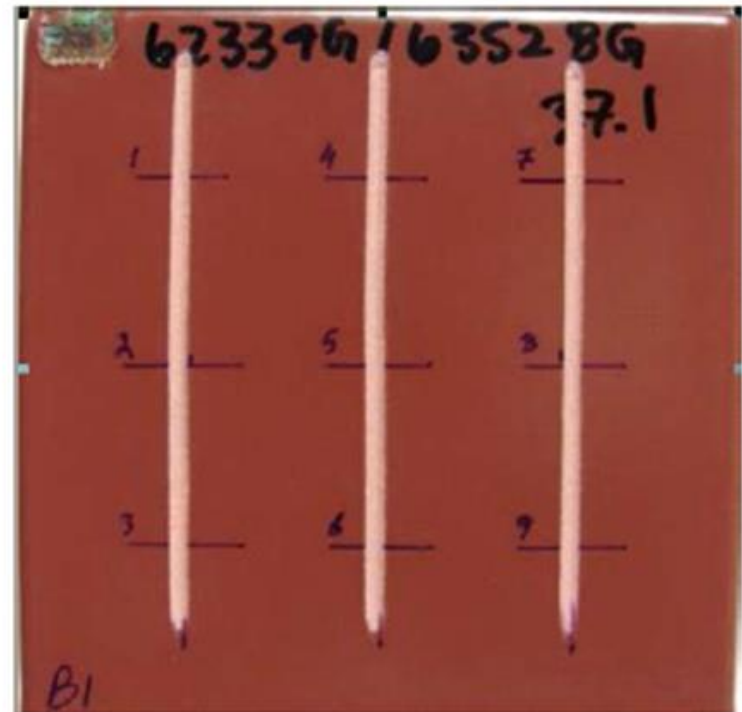
Typical Field Joint Coatings for HDD Applications



HDD Coating Tests



- Adhesion
- Abrasion
- Gouge
- Impact
- Hardness
- CP Compatibility



Gouge Test Results

Typical Results for HDD Applications (Field Joint)



FJC have always been the weak link with HDD applications. Why?



- **Raised girth weld experiences maximum abrasion, gouge and impact forces**
- **Performance data is not pulled from the girth weld location.**
- **Difficult to build consistent epoxy thickness over the girth weld**
- **Impossible to pull a wet film thickness over the girth weld**
- **Difficult to read a dry film thickness on the girth weld**
- **Trying to increase epoxy thickness (60+ mils) over the girth weld results in cracking.**

The corrosion coating at the location that will see the most abuse (girth weld) is based on a visual guess.



Weld bead protection is critical for a successful HDD project

Field Applied Composite ARO



Tri-directional, fiberglass cloth, pre-impregnated with a moisture cured PU resin

Excellent abrasion, impact and gouge resistance

Activated by fresh or salt water

Fast cure times (~ 30 minutes)

Non-hazardous

Extremely easy field installation

Application over various corrosion coatings.

Non-shielding

Used for girth welds or as a ML ARO



Composite Installation



- **Corrosion system can be a 2-part epoxy or heat shrink sleeve**



Composite Installation



Activating the PU resin as material is being applied



Composite Installation



Thickness dependent on HDD conditions



Composite ARO Installation



Compression film is used to compress all of the layers



Composite ARO Installation



Perforation tool used to puncture the compression film which allows the CO² gas and water to escape

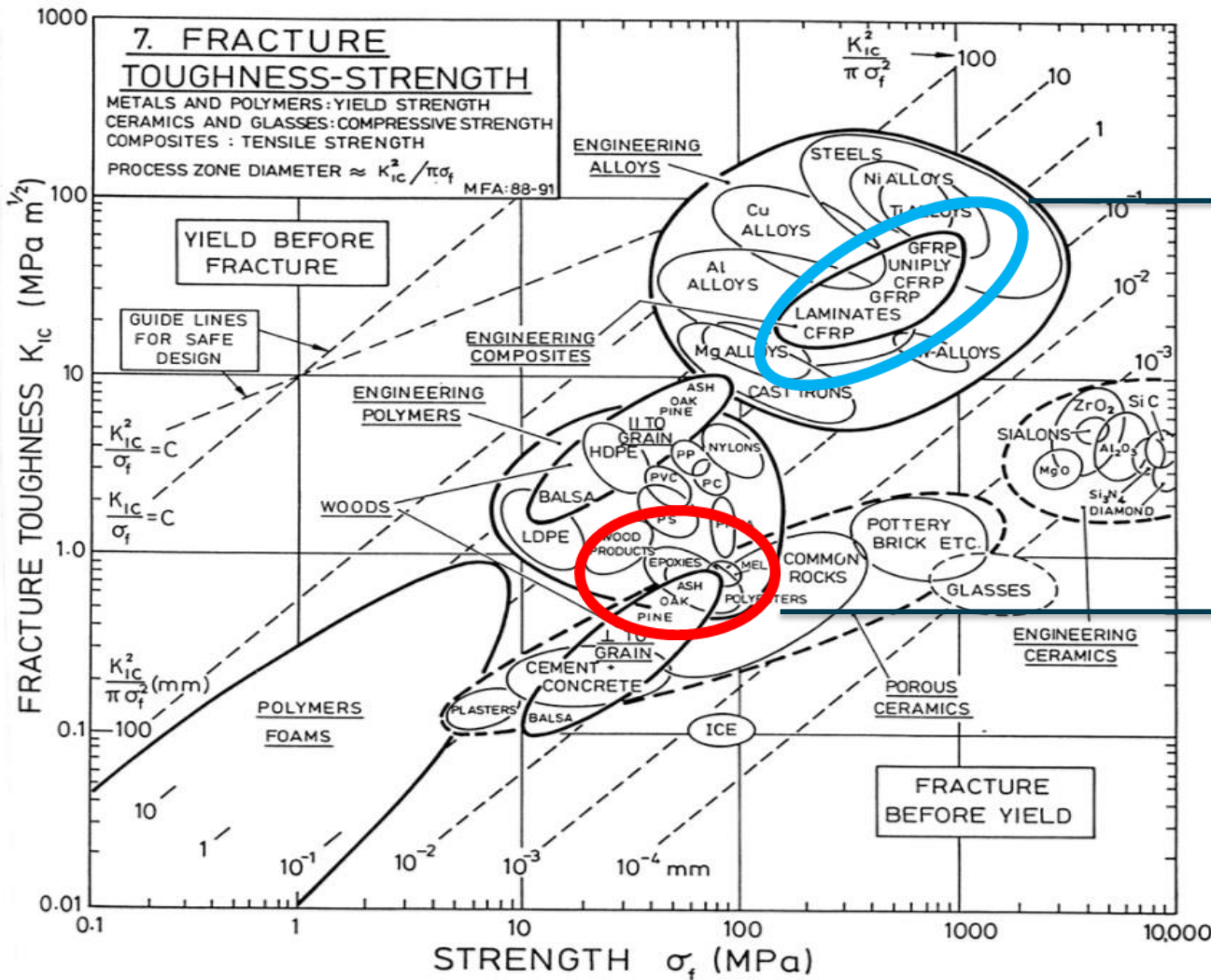


Composite ARO Installation



Cure times are approximately 30 minutes

Fracture Toughness



Composites

20-60X Greater

Epoxies

Results after HDD Application



Results after HDD Application



30" OD Pipe – shale conditions, damage to ML ARO

Results after HDD Application



1,400' of 30"

If you are using a plant applied ARO for an HDD, you should consider a field applied ARO for the area that will experience the most damage.

“Precautions Must Be Taken”



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