Shaw Pipe provides advanced and proprietary products that increase the integrity and performance of the pipeline and ensure its long term operation. Shaw’s products have been selected by clients to protect a range of pipelines in the harshest of environments, from flowlines and gathering lines connecting to the wellhead to large diameter transmission pipelines bringing processed oil and gas to market.

In addition to Shaw Pipe’s existing coating solutions, new products are being developed to address new requirements for abrasion resistance, higher operating temperatures, and installation in extreme cold temperatures to serve the Oil Sands and Arctic regions.

Shaw Pipe operates five ISO 9001-2008 certified pipe coating facilities in Canada capable of meeting all of our client’s requirements. With two facilities in Edmonton, AB, two more in Camrose, AB, and one in Regina, SK, Shaw Pipe’s facilities are strategically located to serve the growth in the Oil Sands region and the Western Canadian Sedimentary Basin.

Shaw Pipe is part of Bredero Shaw, the global leader in pipe coating solutions and employs approximately 4,000 employees located at offices and facilities in fifteen countries. Bredero Shaw provides specialized coating systems and related services for corrosion protection, insulation and weight coating applications on land and marine pipelines including highly engineered corrosion and insulation systems for deepwater applications.

Shaw Pipe is wholly owned by ShawCor Ltd. of Toronto, ON Canada. ShawCor is a global energy services company specializing in products and services for the pipeline and pipe services, and petrochemical and industrial segments of the oil and gas industry and other industrial markets. ShawCor operates through seven wholly owned business units.
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<td>• YJ2K®</td>
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<td>• Fusion Bond Epoxy</td>
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<td>• Dual Layer Abrasion Resistant FBE</td>
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History of Pipe Coatings in Canada

Overview

- **Coal Tar Enamel**: 1940 - 1982
- **Yellow Jacket**: 1950 - Present
- **Polyethylene Tapes**: 1955 - Present
- **3-Layer PE**: 1982 - Present
- **High Performance Composite Coating (HPCC)**: 1990 - Present
- **Wax & Vinyl Tape**: 1945 - 1957
- **Asphalt**: 1951 - 1970
- **Fusion Bond Epoxy**: 1973 - Present
- **HPCC/Side Extruded**: 2005 - Present
Pipeline Coating Selection Considerations

Overview

Functionality
- What is the coating required for?
  - Anti-corrosion
  - Flow Assurance Thermal Insulation
  - Negative buoyancy
  - Mechanical Protection etc.

Soil Conditions/Terrain

Contamination
- Presence of chemicals which might attack the coating such as hydrocarbons, alkalis, acids, chlorides and sulfides

Soil Stress
- Compressive (e.g. clay cycles)
- Reciprocating (often due to temperature cycling of pipeline)
- Unstable soils
- Pipe weight in service

Backfill
- Type of soil (rocky soil, blasted-out rock)
- Backfill material (size & geometry) & method

Line Pipe Properties
- Diameter
- Wall thickness
- Pipe Grade
- Joint length
- Joint weight
- Method of fabrication (ERW, DSAW, SMLS)

Construction Conditions/Constraints

- Operating temperature range and frequency of temperature fluctuations
- Handling methods
- Field Bending requirements
- Storage conditions and duration
- Handling & Installation method
- Contractor experience
- Government regulations
- Cathodic Protection Compatibility
- Pipeline class location

Economics

- Expected life (amortization)
- Cost of coating
- Field repair costs
- Joint completion costs
- Availability

Miscellaneous

- Possible changes in service over the pipeline life cycle
- Interaction with dissimilar coatings
- Process fluid
- Other coating requirements (internal, overcoats)

Note: Refer to CSA Z662-07, Section 9 for detailed requirements for the control of corrosion of steel pipeline systems that are buried, submerged, or exposed to the atmosphere.
Key Factors Affecting Coating Application

Overview

Surface Preparation
- Remove contaminants such as mill scale, rust, dirt, oil & grease
- Eliminate soluble salts such as chlorides and sulfates
- Create optimum steel surface area and profile which will increase total bond strength
- Attain optimum surface temperature, which will improve surface wetting and assist in achieving complete cure (epoxies, urethane etc.)

Process Control
- Application equipment parameters
- Coating thickness
- Cure times (where applicable)
- Cooling rates
- Cutback lengths & cleanliness

Quality Control
- Control of Customer supplied materials (incoming pipe)
- Raw materials
- Surface preparation
- Coating process parameters
- Documentation compliant to ISO 9001:2000 and project specific standard
Properties of Various Pipe Coating Systems

<table>
<thead>
<tr>
<th>Coating Type</th>
<th>Maximum Operating Temperature (°C)</th>
<th>NPS (inches)</th>
<th>Anti-corrosion Coating</th>
<th>Protective &amp; Weight Coatings</th>
<th>Flow Assurance Coating</th>
<th>Internal Coatings</th>
<th>Wet Environments</th>
<th>Rocky Terrain</th>
<th>HDD Applications</th>
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*Dependent on soil and environmental conditions.

** Larger diameters may be possible, please contact your Shaw Representative for more information.
## Manufacturing Locations & Capabilities

**Note:** Pipe size is specified as Nominal Pipe Size

**Larger diameters may be possible. Consult Shaw Pipe Protection for more information.**

**A Portable Plant is available for setup at all Bredero Shaw plants or on location of the project. Sufficient time for plant mobilization is required.***

***For pipe diameters <\=4", the maximum joint length shall be 45ft.**

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<th>Coating Type</th>
<th>Camrose I Alberta</th>
<th>Camrose II Alberta</th>
<th>Edmonton 21st Street Alberta</th>
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*Large diameters may be possible. Consult Shaw Pipe Protection for more information.*
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<td>GTS-100</td>
<td>100°C</td>
<td>Grit Blast-Near White</td>
<td>Contact Canusa</td>
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<tr>
<td>HDD: YJ2K</td>
<td>85°C</td>
<td>TBK-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
<td>Standard Stock</td>
<td></td>
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<tr>
<td>HDD: YJ2K-HT</td>
<td>100°C</td>
<td>TBK-100</td>
<td>100°C</td>
<td>Grit Blast-Near White</td>
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<tr>
<td>Insul-8 85</td>
<td>85°C</td>
<td>Inner: INR-95</td>
<td>85°C</td>
<td>Hand Tool Clean</td>
<td>Standard Stock</td>
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<td></td>
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<td>Outer: K-60 XXX-600</td>
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<tr>
<td>Insul-8 110</td>
<td>110°C</td>
<td>Inner: INR-110</td>
<td>110°C</td>
<td>Hand Tool Clean</td>
<td>Standard Stock</td>
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<td>Outer: K-60</td>
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<tr>
<td>Insul-8 HT</td>
<td>150°C</td>
<td>Insul-8 HT Field Sys.</td>
<td>150°C</td>
<td>Grit Blast-Near White</td>
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<tr>
<td>HDD: Insul-8</td>
<td>85°C/110°C</td>
<td>TBK-60</td>
<td>85°C/110°C</td>
<td>Hand Tool Clean</td>
<td>Standard Stock</td>
<td>Inner Sleeve Still Required</td>
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<tr>
<td>FBE</td>
<td>110°C Dry 65°C Wet</td>
<td>K-60</td>
<td>60°C</td>
<td>Hand Tool Clean</td>
<td>Standard Stock</td>
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<td>HBE-95 BG/SG’</td>
<td>95°C</td>
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<td>HBE-HT BG/SG’</td>
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<td></td>
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<td>GTS-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
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<td>GTS-HT</td>
<td>120°C</td>
<td>Grit Blast-Near White</td>
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<tr>
<td>HDD:FBE</td>
<td>110°C Dry 65°C Wet</td>
<td>TBK-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
<td>Standard Stock</td>
<td>E-Primer Required-Order Separately</td>
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<tr>
<td></td>
<td></td>
<td>TBK-HT</td>
<td>120°C</td>
<td></td>
<td>Contact Canusa</td>
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<tr>
<td>Nap-Gard Gold</td>
<td>120°C</td>
<td>GTS-HT</td>
<td>120°C</td>
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<tr>
<td>HPCC</td>
<td>85°C</td>
<td>GTS-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
<td>Standard Stock</td>
<td>E-Primer Required-Order Separately</td>
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<td>GTS-100</td>
<td>100°C</td>
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<td>Contact Canusa</td>
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<tr>
<td>HDD:HPCC</td>
<td>85°C</td>
<td>TBK-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
<td>Standard Stock</td>
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<tr>
<td></td>
<td></td>
<td>TBK-100</td>
<td>100°C</td>
<td></td>
<td>Contact Canusa</td>
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<tr>
<td>Dual Powder</td>
<td>110°C Dry 65°C Wet</td>
<td>TBK-80</td>
<td>85°C for&lt;16&quot; 80°C for&gt;16&quot;</td>
<td>Standard Stock</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>TBK-HT</td>
<td>120°C</td>
<td></td>
<td>Contact Canusa</td>
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<tr>
<td>Risers</td>
<td>60°C</td>
<td>K-60 UV</td>
<td>60°C</td>
<td>Power Tool Clean</td>
<td>Contact Canusa</td>
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<td>CLH</td>
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<td>Sold in Bulk Roll Only Closure Seal for sleeve</td>
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</tr>
</tbody>
</table>

1. St2/SP2 - Hand Tool Clean  
2. SIS SA 2 ½ and SSPC SP 10 - Near White Finish (Grit Blast Required)  
3. St3/SP3 - Power Tool Clean  
4. High Build Epoxy Available in Brush Grade and Spray Grade  
5. Horizontal Directional Drill
Yellow Jacket®

Product Description
Yellow Jacket® is a two-layer polyethylene anti-corrosion coating system, which consists of a continuous outer sheath of high-density polyethylene extruded over a rubber modified asphalt based adhesive. Yellow Jacket® provides external protection for pipe used in the oil, gas and waterworks industries where moderate operating temperatures and good handling capabilities are required.

Yellow Jacket® was first introduced in the pipe coating industry over 50 years ago and has since proven itself to be an extremely reliable coating technology. While undergoing constant improvement in material design and manufacturing methodology, Yellow Jacket® has continued to be one of the leading technologies for pipeline anti-corrosion protection. With this track record of performance, engineers feel confident that their pipelines are well protected.

Tough, Durable System
Yellow Jacket’s® tough outer layer of high-density polyethylene combined with the superior sealant qualities of the adhesive enables Yellow Jacket® to easily withstand the stresses associated with handling, laying and backfilling of the pipeline. This results in reduced manpower requirements during installation, as well as a significant reduction in repair costs.

Lower Total Installed Cost
Yellow Jacket®’s two layer system provides a long-term barrier to corrosion and moisture in various soil conditions. Yellow Jacket® was formulated to resist most biological, chemical and environmental contaminants found in the soil, allowing for the use of native backfill to reduce the overall project cost. The bonding properties of the mastic adhesive facilitate in the overall coating’s resistance to cathodic disbondment, thereby minimizing the cost of cathodic protection requirements.
Features & Benefits
• Excellent corrosion, moisture, shear and soil stress resistance
• Exceptional handling and impact resistance
• Crosshead extrusion is seamless and lamination free
• Designed to withstand field bending up to 2.5 degrees per pipe diameter @ -40°C
• Capable of tolerating a wide range of operating conditions

Options/Variations
• The thickness of the outer layer can be varied to offer greater mechanical protection in very rugged environments.
• Sealant formulations can be varied to obtain specific performance requirements.
• The addition of carbon black to the virgin polyethylene resin provides additional stabilizers, which protect the polyethylene from ultra-violet light during temporary storage prior to buried installation.

Operating, Handling and Installation Temperatures
• -40°C to 60°C
• NPS ≤ 2 is limited to 55°C

Standard Cutbacks
• Adhesive: 75 ± 25mm
• Polyethylene: 125 ± 25mm

Compliancy
• Coating System Compliant to CSA Z245.21 (Systems A1 and A2) & Proposed ISO 21809-4
• Quality System Compliant to ISO 9001:2008

Field Holiday Inspection
• Recommended Maximum Inspection Voltage: 12,000 Volts Pulse Voltage
• Recommended Detector: SPY Model 725 or 790 High Voltage or equivalent
Joint Protection & Repairs
- K-60 Heat Shrink Sleeves
- MS-1 Melt-stick
- Coating Repair Patches (CRP)
- Refer to Canusa-CPS web site: [http://www.shrinksleeves.com](http://www.shrinksleeves.com)

*Note: Ensure that maximum operating temperatures of the joint protection material coincide with the maximum operating temperature of the pipeline.*

Material Thickness Chart

<table>
<thead>
<tr>
<th>NPS(inches)</th>
<th>OD(mm)</th>
<th>Minimum Thickness Values</th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adhesive mm (mils)</td>
<td>Polyethylene mm (mils)</td>
<td>Total mm (mils)</td>
<td></td>
</tr>
<tr>
<td>&lt;2.5</td>
<td>&lt;75</td>
<td>0.15 (5.9)</td>
<td>0.55 (21.7)</td>
<td>0.70 (27.6)</td>
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</tr>
<tr>
<td>2.5-4</td>
<td>75-115</td>
<td>0.15 (5.9)</td>
<td>0.60 (23.6)</td>
<td>0.75 (29.5)</td>
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<tr>
<td>&gt;4-6</td>
<td>&gt;115-170</td>
<td>0.15 (5.9)</td>
<td>0.70 (27.6)</td>
<td>0.85 (33.5)</td>
<td></td>
</tr>
<tr>
<td>&gt;6-10</td>
<td>&gt;170-275</td>
<td>0.15 (5.9)</td>
<td>0.85 (33.5)</td>
<td>1.00 (39.4)</td>
<td></td>
</tr>
<tr>
<td>&gt;10</td>
<td>&gt;275</td>
<td>0.20 (7.9)</td>
<td>1.05 (41.3)</td>
<td>1.25 (49.2)</td>
<td></td>
</tr>
</tbody>
</table>

*Typical values represent average laboratory values and are intended as guidelines only.*
YJ2K®

**Product Description**
YJ2K® is a bonded multi-layer anti-corrosion coating system which consists of an inner fusion bond epoxy primer layer, followed by an extruded copolymer adhesive and a durable outer layer of high-density polyethylene.

YJ2K® was developed for buried *oil* and *gas pipelines* in environments where superior corrosion resistance, adhesion, impact and cathodic disbondment properties are required at elevated operating temperatures.

**Long Term Corrosion Protection**
YJ2K®’s fusion bond epoxy component exhibits exceptional adhesion to steel, which provides an outstanding barrier to corrosion and moisture in various soil environments, while offering excellent cathodic disbondment protection.

**Superior Mechanical Protection & Low Temperature Flexibility**
The durable high-density polyethylene outer jacket layer protects pipelines during transportation and installation thereby reducing costly repairs while also providing added in-ground protection against shear forces, chemicals and abrasive soil conditions. The sophisticated adhesion properties of the FBE promote remarkable flexibility characteristics, which allow for field bending in cold weather applications.

**Features & Benefits**
- Excellent corrosion, moisture, shear and soil stress resistance
- Exceptional adhesion to steel which provides excellent resistance to cathodic disbondment
- Crosshead extrusion is seamless and lamination free
- Designed to withstand field bending up to 2.5 degrees per pipe diameter @-40°C
- Capable of tolerating a wide range of operating conditions
Options/Variations

- Polyethylene thickness can be varied to offer greater mechanical protection in rugged environments.

- The addition of carbon black to the virgin polyethylene resin provides additional stabilizers which protect the polyethylene from ultra violet light during temporary storage prior to buried installation.

Operating, Handling and Installation Temperatures

- Standard YJ2K®: -40°C to 85°C

Standard Cutbacks

- Adhesive: 75 ± 25mm
- Polyethylene: 125 ± 25mm

Compliancy

- Coating System Compliant to CSA Z245.21 (System B1) & Proposed ISO 21809-1
- Quality System Compliant to ISO 9001:2008

Field Holiday Inspection

- Recommended Maximum Inspection Voltage: 3500 Volts
- Recommended Detector: SPY model 715 or 780 DC Low Voltage or equivalent

*Note: Voltage may have to be adjusted down during wet weather and/or wet pipe conditions to avoid creating holidays in the coating*
Joint Protection & Repairs

- **Standard YJ2K®**
  - Two part liquid epoxy primer (E Primer) and GTS-80 Heat Shrink Sleeve

- **YJ2K® HT**
  - Two part liquid epoxy primer (HBE-HT) and GTS-HT 100 Heat Shrink Sleeve

- Refer to Canusa-CPS web site: [http://www.shrinksleeves.com](http://www.shrinksleeves.com)

*Note: Ensure that maximum operating temperatures of the joint protection material coincide with the maximum operating temperature of the pipeline.*

<table>
<thead>
<tr>
<th>Material Thickness Chart</th>
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</thead>
<tbody>
<tr>
<td><strong>NPS(inches)</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td>&lt;3.5</td>
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<tr>
<td>3.5 and larger</td>
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</table>

*Typical values represent average laboratory values and are intended as guidelines only.*
Fusion Bond Epoxy

Product Description
Fusion Bond Epoxy (FBE) is a high-performance, anti-corrosion powder coating which is spray applied to hot rotating pipe using electro-statically charged powder.

Fusion Bond Epoxy powder-coating systems are used extensively where superior coating bonds, chemical resistance, soil stress and cathodic disbondment protection of pipelines is required. These coatings can function as stand-alone coatings as well as a part of multi-layer coatings, depending on the pipeline service conditions.

Since their introduction as an anti-corrosion coating in early 1960’s, FBE coating formulations have gone through vast improvements and developments. Today, various types of FBE coatings are available that have been tailor made with different chemical and physical properties to meet the varying requirements of the buried oil, gas and waterworks pipelines industry.

Long Term Corrosion Protection
FBE’s exceptional adhesion to steel facilitates in the long-term corrosion resistance of pipelines, while demonstrating significant chemical resistance under most soil conditions. The bonding characteristics of FBE to steel also facilitate in the promotion of cathodic disbondment resistant properties, which reduces the costs affiliated with cathodic protection during the operation of the pipeline.

Advanced Mechanical and Chemical Protection
Fusion Bond Epoxy powders can also be applied as dual layer systems, which provide tough physical properties that minimize damage during handling, transportation, installation and operation.
Features and Benefits

- Excellent corrosion, chemical and soil stress resistant properties
- Demonstrates exceptional adhesion to steel properties which promote cathodic disbondment resistance
- Exhibits remarkable flexibility and handling characteristics
- FBE coating system does not shield Cathodic Protection current.
- Designed to withstand field bending up to 2.5 degrees per pipe diameter @ -30°C, with a nominal coating thickness of 14 mils.

Options/Variations

- Advanced manufacturing techniques allow FBE to be applied in a wide range of thicknesses to cost effectively meet unique project specifications and performance requirements.

- Low Application Temperature Fusion Bond Epoxy Powder Coating (LAT/FBE) is available for strain based pipeline designs that require application at a lower temperature (~185ºC) than the conventional FBE coating system (245ºC). The unique application process coating enables the exact mechanical properties of the steel to be maintained making it ideal for high strength pipelines (e.g.: X80 – X120 steel pipe).

- High temperature Fusion Bond Epoxy is available to withstand pipeline-operating temperatures up to 150ºC*.

Standard Cutbacks

- 75 +12/-38mm (manual weld)
- 125 +12/-38 mm (automatic)
Operating, Handling and Installation Temperatures

- Standard FBE: -40°C to 110°C*
- FBE HT: -40°C to 150°C*

Compliancy

- Coating System compliant to CSA Z245.20 (Systems 1A & 1B) & Proposed ISO 21809-2
- Quality System compliant to ISO 9001:2008

Field Holiday Inspection

- Recommended Maximum Inspection Voltage: 125 Volts DC Continuous Voltage per mil of coating thickness
- Recommended Detector: SPY model 715 OR 780 Low Voltage or equivalent

*Note: Recommended maximum voltage for frost and/or wet conditions – 100 volts per mil of coating thickness.

Joint Protection & Repairs

- Canusa’s HBE-95 & HBE-HT two-part liquid epoxy kits (also available in bubble packs or cartridges)
- All Canusa Heat Shrinkable products are compatible with FBE coatings
- Refer to Canusa-CPS web site: http://www.shrinksleeves.com

*Note: Ensure that maximum operating temperatures of the joint protection material coincide with the maximum operating temperature of the pipeline

*Soil type, moisture content, temperatures and coating thickness all influence the upper operating temperature limit as per manufacturers’ published literature.
Dual-Layer Abrasion Resistant Fusion Bond Epoxy

Product Description
Dual-Layer Abrasion Resistant Fusion Bond Epoxy is a unique coating system which consists of an anti-corrosion FBE layer followed by an abrasion resistant FBE overcoat, which are sequentially sprayed in powder form onto hot rotating pipe using electro-statically charged powder.

Dual Layer Abrasion Resistant FBE coating systems exhibit excellent characteristics in pipeline applications that require elevated operating temperatures in wet environments. This coating system is typically specified for oil and gas pipelines used in anti-abrasion service applications such as directional drilling, road and river crossings and rocky mountainous terrain.

Long Term Corrosion Protection
Dual Layer fusion bond epoxy systems exhibit exceptional adhesion qualities, which facilitate in the long-term corrosion resistance of steel pipelines, while demonstrating significant chemical resistance under most soil conditions. The bonding characteristics of FBE to steel also provide excellent resistance to cathodic disbondment, which reduces the costs affiliated with cathodic protection during the operation of the pipeline.

Impact and Abrasion Resistance
This distinct dual layer coating system was designed to safeguard against abrasion and impact damage while offering ample flexibility, which serves to protect against possible damage to the anti-corrosion coating during pipe transportation, pipeline construction, road bores and directional drills.
Features and Benefits

- Excellent corrosion, chemical and soil stress resistant properties
- Demonstrates exceptional adhesion to steel properties which promote cathodic disbondment resistance
- Provides tough physical properties which minimize damage to pipe
- Dual Layer FBE coating system does not shield Cathodic Protection current.
- Designed to withstand field bending up to 1.5 degrees per pipe diameter @ -30°C

Options/Variations

- An alternative variation to the standard dual-layer system is NapGard’s High Temperature Gold Dual Powder system, which exhibits excellent water resistant properties and can be used on pipelines with operating temperatures up to 130°C*.

Field Holiday Inspection

- Recommended Maximum Inspection Voltage: 125 Volts DC Continuous Voltage per mil of coating thickness
- Recommended Detector: SPY model 715 OR 780 Low Voltage or equivalent

Note: Recommended maximum voltage for frost and/or wet conditions – 100 volts per mil of coating thickness

Joint Protection & Repairs

- Canusa’s TBK-80 Directional Drilling Kits
- Refer to Canusa-CPS web site: http://www.shrinksleeves.com

Note: Ensure that maximum operating temperatures of the joint protection material coincide with the maximum operating temperature of the pipeline.

Standard Cutbacks

- 75 +12/-38mm (manual weld)
- 125 +12/-38 mm (automatic)

Operating, Handling and Installation Temperatures

- -40°C to 110°C*
Compliancy

- Coating System compliant to CSA Z245.20 (Systems 2B)
- Quality System compliant to ISO 9001:2008

*Soil type, moisture content, temperatures and coating thickness all influence the upper operating temperature limit as per manufacturers' published literature.
High Performance Composite Coating

Product Description
High Performance Composite Coating (HPCC) is a proprietary composite system that represents the latest development in anti-corrosion systems. The product consists of fusion bond epoxy anti-corrosion layer, a polyolefin adhesive and a tough polyethylene outer jacket. The unique application process of HPCC provides a fused, homogeneous profile that was engineered for maximum protection in severe environments.

HPCC system was designed primarily to protect buried oil and gas pipelines in environments where superior mechanical protection, moisture and corrosion resistance and high operating performance characteristics are required.

History
HPCC coating system was designed as a result of a seminar that took place in December of 1992 between Shaw and executive personnel of various major transmission companies involved in the design of pipeline projects. The objective of the meeting was to discuss what the industry was looking for in terms of new or improved coatings. This exchange of ideas highlighted a need the industry saw for a coating system that offered improved resistance to moisture ingestion in hot/wet environments, coupled with the superior field handling characteristics of fusion bond epoxy powder systems, at a comparable cost.

Long Term Corrosion Protection
The FBE component of HPCC provides excellent adhesion to steel, which promotes superior long-term corrosion as well as provides cathodic disbondment resistance; this results in reduced costs related to cathodic protection during the operational life of the pipeline.

Superior Mechanical Protection
The polyethylene component protects the pipeline during transportation, thereby, reducing costly repairs while also providing added in-ground protection against shear forces, aggressive chemicals and abrasive soil conditions. During construction, this system demonstrates excellent field handling and flexibility characteristics, thereby minimizing installation costs.
Features & Benefits

- Enhanced water permeation resistance which protects against moisture ingress
- Superior field handling and flexibility characteristics allows for easier cold weather installation
- Application process prevents intra-layer delamination and loss of adhesion
- HPCC provides optimum, uniform coverage of the weld bead profile, thus preventing “tenting” and weaknesses in the coating cross-section.
- Designed to withstand field bending up to 2.5 degrees per pipe diameter @ -30°C

Options/Variations

- Advanced manufacturing techniques allow HPCC to be applied in a wide range of thicknesses to cost effectively meet unique project specifications and performance requirements.
- Where superior mechanical protection in severe environments is required, an additional layer of tough high-density polyethylene (HDPE) can be applied by side extrusion. This HDPE thickness can be adjusted to meet specific project requirements. Shaw has developed a calculator to provide a method for assessing the incremental costs for pipeline construction associated with the use of HPCC SE over FBE in Northern environments.

Operating, Handling and Installation Temperatures

- -40°C to 85°C

Field Holiday Inspection

- Recommended Maximum Inspection Voltage: 3500 Volts
- Recommended Detector: SPY model 715 or 780 DC Low Voltage or equivalent

Note: Voltage may have to be adjusted down during wet weather and/or wet pipe conditions to avoid creating holidays in the coating.
Joint Protection & Repairs

- Two part liquid epoxy primer (E Primer)
- Canusa’s GTS-65 3-layer, GTS-80 3-layer, GTS-100 3-layer Heat Shrink Sleeves
- MS-1 Melt-stick
- Coating Repair Patches (CRP)
- Refer to Canusa-CPS web site: http://www.shrinksleeves.com

*Note: Ensure that maximum operating temperatures of the joint protection material coincide with the maximum operating temperature of the pipeline.*

Standard Cutbacks

- 75 +12/-38mm (manual weld)
- 125 +12/-38 mm (automatic)

Compliancy

- Coating System Compliant to CSA Z245.21 (System B2)
- Quality System Compliant to ISO 9001:2008

Material Thickness Chart

<table>
<thead>
<tr>
<th>NPS(inches)</th>
<th>Primer mm (mils)</th>
<th>Adhesive mm (mils)</th>
<th>Polyethylene mm (mils)</th>
<th>Total mm (mils)</th>
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</thead>
<tbody>
<tr>
<td>All diameters - Standard HPCC</td>
<td>0.12 (4.7)</td>
<td>0.10 (3.9)</td>
<td>0.45 (17.7)</td>
<td>0.67 (26.4)</td>
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<tr>
<td>All diameters - Heavy Duty HPCC</td>
<td>0.12 (4.7)</td>
<td>0.10 (3.9)</td>
<td>1.23 (48.4)</td>
<td>1.45 (57.1)</td>
</tr>
</tbody>
</table>

*Typical values represent average laboratory values and are intended as guidelines only.*
Insul-8® Coating Systems

Product Description

**Insul-8® 85**

Insul-8® 85 is a thermal efficiency coating system that was developed as a cost-effective means to reduce overall heat losses of buried steel pipe operating at lower temperatures.

This insulation system consists of an inner anti-corrosion tape and primer, followed by a spray-applied polyurethane foam and finished with an extruded layer of high-density polyethylene.

**Insul-8® 110/Insul-8® HT**

Insul-8® 110 & Insul-8® HT thermal insulation systems were developed to reduce overall heat loss in buried steel pipe where high operating temperatures are required.

These insulation systems consist of an inner FBE layer, followed by a spray-applied polyurethane foam and finished with an extruded layer of high-density polyethylene. The Insul-8® HT system uses special heat resistant FBE as well as a polyurethane foam system certified in accordance with the European Standard EN253 for a service life of 30 years at 150°C.

**Outstanding Thermal Efficiency**

The closed cell and water resistant polyurethane foam serves to reduce heat loss which, in turn, prevents hydrate formation in gas pipelines, maintains viscosity of hot oil and bitumen lines as well as provides freeze protection for water and sewage lines. The polyethylene topcoat serves to protect the foam from mechanical damage during handling as well as preventing moisture ingress. The handling characteristics of all complete insulated pipe systems exhibited excellent impact, shear strength and flexibility characteristics at cold temperatures.
Features & Benefits
Polyethylene jacket provides a watertight barrier to prevent moisture ingress
Insul-8® 110 & Insul-8® HT Systems are compatible with and can be applied over a
variety of anti-corrosion coatings.
Both the fusion bond epoxy anti-corrosion layer and the foam insulation of the Insul-
8®110 & Insul-8®HT Systems can be tailored to meet project specific design
temperature requirements.

- For Standard foam with an approximate compressive strength of 45psi, the typical
  initial thermal conductivity value is ≤0.023W/mK (0.160Btu. in/h.ft².°F), when
  measured at a mean temperature of 23.8°C (75°F).
- For Standard foam with an approximate compressive strength of 70psi, the typical
  initial thermal conductivity value is ≤0.024W/mK (0.167Btu. in/h.ft².°F), when
  measured at a mean temperature of 23.8°C (75°F).
- For High Temperature foam with an approximate compressive strength of 70psi, the
  typical initial thermal conductivity value is ≤0.026 W/mK (0.180Btu. in/h.ft².°F),
  when measured at a mean temperature of 23.8°C (75°F).

Options/Variations
- The polyurethane foam can be applied in a variety of insulation thicknesses such
  as 1”, 1½” and 2”, to meet specific project requirements

Operating, Handling and Installation Temperatures
- -35°C to 85°C* (Insul-8® 85)
- -35°C to 110°C* (Insul-8® 110)
- -35°C to 150°C* (Insul-8® HT)

*Excessive thermal cycling beyond maximum operating temperature limitations may reduce the overall
maximum operating temperature rating.
Joint Protection & Repairs

Insul-8® 85 & Insul-8® 110

Corrosion Barrier: INR-110
Polyurethane Foam: Half shells are supplied or field foaming is arranged by the customer
Outer Polyethylene Jacket: K-60 Heat Shrink Sleeves
Refer to Canusa-CPS web site: http://www.shrinksleeves.com

Insul-8® HT

- “Insul-8® Field System” consisting of HBE-HT, Canusa HT Foam and Canusa SuperCase – CSC-X

- Refer to Canusa-CPS web site: http://www.shrinksleeves.com

Standard Cutbacks
- 178 +12/-0mm

Compliancy
- Insul-8® HT Polyurethane Foam Compliant to EN 253
- Insul-8® 110/HT Corrosion Layer Compliant to CSA Z245.20 (System 1A or 1B)
- Outer Jacket Layer Compliant to applicable sections of CSA Z245.21
- Quality System Compliant to ISO 9001:2008
INSUL-8® AG

Product Description
Shaw Pipe has successfully entered into the aboveground pipe insulation market with our Insul-8® AG pre-insulated pipe coating system, which was developed specifically to service the growing Oil Sands market. This coating system consists of a flexible blanket of Aspen Aerogels’ Pyrogel insulation wrapped directly onto the pipe, which is then protected by an outer aluminum cladding. Given that Aerogels possesses the lowest thermal conductivity of any known solid, equal thermal resistance can be achieved at a fraction of the thickness, resulting in reduced material volume, increased rack efficiency and enhanced logistical savings.

Unparalleled Thermal Efficiency
The exceptional thermal performance achieved by using Aerogels’ insulation will allow end users to eliminate electric heat tracing on pipelines saving both capital costs and operating expenses while extending cool-down windows that are critical for maintenance. Pre-insulated pipe significantly reduces site insulation labor costs at the congested, space-constrained Oil Sands sites. It also will reduce the project impact on site traffic that is in close proximity to the pipeline right of way.

Features & Benefits
- Pyrogel® achieves this industry-leading thermal performance in a flexible, environmentally safe and easy-to-use product.

- Pyrogel® is a hydrophobic material that repels liquid water while still allowing vapor to pass through, helping to prevent corrosion.

- Landfill disposable, shot-free, with no respirable fiber content, which minimizes the environmental impact.

- Ideal for insulating the curved surfaces and can easily conform to the complex shapes typical of today’s refining and petrochemical infrastructure.

- Pyrogel® can be cut using conventional cutting tools including scissors, tin snips, and razor knives.

- Factory application reduces site traffic, total installed costs and improves project schedules.
• Reduced material volume, high packing density, and low scrap rates can reduce logistics costs by a factor of five or more compared to rigid, pre-formed insulations.

• Pyrogel® recovers its thermal performance even after compression events as high as 100 psi.

• Refer to Aspen Aerogels’ web site: http://www.aerogel.com/

Operating, Handling and Installation Temperatures
• Insulates pipelines operating at temperatures up to 650°C

Standard Cutbacks
• Insulation: 355 ± 13mm
• Cladding: 381 ± 13mm

Compliancy
• Quality System Compliant to ISO 9001:2008
SureFlo® Cement Mortar Lining

**Product Description**
SureFlo® CML is a centrifugally applied continuous lining of dense Portland cement mortar with a smooth and uniform finish. This product was developed to provide an economical form of internal corrosion and abrasion protection and is used primarily in *water injection* and *disposal lines*. The product is also suitable for *potable water lines* but should not be specified for lines where hammer conditions exist.

The concept of SureFlo® CML has been utilized for over a century in municipal water service and mainlines which demonstrates this technology’s reliability and sustainability.

**Features & Benefits**
Economical and lasting protection against the corrosive effects of saline solutions and other types of industrial liquids and wastes
Excellent structural and spall-resistant properties
Capable of tolerating a wide range of operating conditions
SureFlo® CML is wholly compatible with any external Shaw coating system.
A full complement of pre-fabricated bends and fittings are available

**Options/Variations**
Pre-Krete cement can be substituted in place of Portland cement to provide effective corrosion, abrasion and chemical resistance in various corrosive and acidic environments.

**Operating, Handling and Installation Temperatures**
- -40°C to 300°C

**Compliance**
- Quality System Compliant to ISO 9001:2008
SureFlo® Flow Efficiency Coating

Product Description
SureFlo® FEC is a thin film internal epoxy coating designed to improve the flow of non-corrosive gas in line pipe.

This coating system can be used to transport non-corrosive gas containing trace amounts of hydrogen sulfide or sulphur compounds, less than 2% by volume of carbon dioxide, traces of lubricating oil and small quantities of line hydrates, condensates, dirt and water.

Ultra Smooth Finish
The application of SureFlo® FEC replaces the internal rough surface of a steel pipe with a smooth surface finish. This results in a reduction in friction and turbulence which increases flow efficiency. This may allow for the use of a smaller diameter pipe or lower compression requirements, which consequentially reduces capital and operating costs.

Improved Internal Surface Cleanliness
After application of SureFlo® FEC, the clean internal surface of the pipe provides corrosion protection prior to installation and allows for easier visual inspection. In addition, the cleaner surface reduces the cost and effort of drying the pipe after hydrostatic testing.

Features & Benefits
• Improved pigging conditions
• Designed to withstand field bending up to 2.5 degrees per pipe diameter @ -30°C.
• SureFlo® FEC is wholly compatible with any external Shaw coating system.

Operating, Handling and Installation Temperatures
-40°C to 139°C

Compliancy
• Coating System Compliant to API RP 5L2
• Quality System Compliant to ISO 9001:2008
Compression Coat (Concrete Weight Coating)

Product Description
Compression Coat (CWC) is a wire reinforced concrete coating system that was developed primarily to provide negative buoyancy and mechanical protection for pipelines in subsea and wet environments.

The CWC coating system uses a spiral wrap application method, making it ideal for both small and large diameter pipelines. While this coating system can be plant applied, it is currently the industry’s leading concrete coating system for projects requiring rapid mobilization or coating near the right-of-way.

Negative Buoyancy and Mechanical Protection
Compression Coat can be applied in a wide range of densities and thicknesses to meet project requirements. This feature can optimize negative buoyancy and mechanical protection while minimizing cost. The Compression Coat system also offers a consistent and uniform thickness with minimum weight variance.

Excellent Compatibility
Compression Coat is fully compatible with any Shaw coating system and does not affect the operating temperatures of these coatings. This ensures that the most appropriate weight coating system is selected without compromising the long-term corrosion protection or flow assurance of the pipeline.

Features & Benefits

- The standard Compression Coat system can be enhanced further with additional features including bendability slots, crack inducers, buckle arrestors and sacrificial anodes.

- Compression Coat does not compromise the cathodic protection system of the pipeline.

- Shaw Pipe has a software program available to calculate negative buoyancy on a per project basis.
Compliance

- Quality System Compliant to ISO 9001:2008

Standard Cutbacks

- 305 +25/-0mm
Negative Buoyancy Formulae

A. Pipe Joints Coated

\[
\text{Neg. buoyancy} = \frac{\text{Wet Wt.} \& \text{ Wt. Joint Material} - \text{Total Buoyancy} - \text{Wt. Loss}}{\text{Pipe Length}}
\]

This formula assumes that the joint area will be coated to the same diameter as the coated pipe. The dry density is used in the formula for the joint material; therefore, the weight loss does not apply to the joint material.

B. Pipe Joints Not Coated

\[
\text{Neg. buoyancy} = \frac{\text{Wet Wt.} - \text{Buoyancy of Coated Pipe} - \text{Buoyancy of Uncoated ends} - \text{Wt. Loss}}{\text{Pipe Length}}
\]

This formula assumes that the joint area will be left uncoated. The negative buoyancy calculated will therefore be the average over the joint length.

Definition of Terms

**Negative Buoyancy** (kg/m) = weight in water of the coated pipe based on the dry concrete density. Absorption of water by the concrete will increase the negative buoyancy slightly but this absorption will not be compensated for in the formulae.

**Wet Weight** (kg) = weight of the freshly coated pipe as determined from the scale.

**Wt. Joint Material** (kg) = Weight of material that will be applied to the joint area in the field.

**Total Buoyancy** (kg) = The total buoyancy of the coated pipe as based on the concrete diameter and total pipe length assuming that the joints are coated to the same outside diameter as the coating on the pipe. This is equal to the weight of water or other fluid displaced by the coated pipe.

**Buoyancy Of Coated Pipe** (kg) = The total buoyancy of the coated pipe as based on the concrete diameter and total pipe length assuming that the joints are coated to the same outside diameter as the coating on the pipe. This is equal to the weight of water or other fluid displaced by the coated pipe.

**Buoyancy Of Uncoated Ends** (kg) = the buoyancy of the uncoated pipe ends based on outside diameter of the corrosion coating.

**Wt. Loss** (kg) = The loss of weight as the concrete coating cures and dries. It is based on a percentage weight loss of the concrete coating.
Repairs Using Grout Kit

- Apply tape on both sides of damaged area, to prevent plastic wrap from unraveling.

- Cut away plastic wrap to expose damaged area.

- Carefully remove sufficient material to expose wire. Ensure wire position is within specification. Adjust accordingly by cutting wire and tightening or loosening.

- A mold (or cast) of thick polyethylene such as 1500 micrometers (60 mils) is wrapped around pipe over the damaged area. Mold is extended approximately 150mm (6”) past the damaged area. Mold is overlapped 75mm (3”) around pipe.

- Tape is secured to mold on pipe*.

- Cut a 50 mm x 150 mm (2” x 6”) hole in top of mold in center of damaged area.

- Mix grout (available in both a summer and winter grade) to a pourable consistency.

- Pour grout into hole, ensuring hole is completely filled.

- Cover hole with tape.

- Once repair has sufficiently cured, plastic is removed, and area is re-taped.

*When a repair is required at the end of the joint, a material with equal thickness to the coating shall be secured on the end of the pipe to support the mold.
Recommended Procedures for Tie-Ins
CWC coated pipe that requires cutting during tie-ins should be cut with a heavy-duty circular saw fitted with a depth guide and a masonry blade using the following procedure:

1. Set up depth guide to 3/4 of CWC thickness, maximum (this setting should be rechecked frequently).

2. Align a guide at a point sufficiently back and parallel to the proposed tie-in to allow for the bevel cutting equipment; place the cutting equipment next to this guide. The guide can be a steel band or a guided masonry saw.

3. Cut the CWC circumferentially completely around the pipe, parallel to the proposed tie-in.

4. Move cutting equipment to a point on the other side of the proposed tie-in to allow for the bevel cutting equipment, or the length that is required to cut pipe.

5. Cut the CWC circumferentially completely around the pipe, parallel to the proposed tie-in.

6. After the circumferential cuts are completed, cut the CWC longitudinally at 90°, 180°, 270° and 360°, to the distance corresponding to the Rock Jacket that is to be removed.

7. After all cuts are completed; spread all cuts with a dull rubber-tipped instrument to ensure that all the wire has been cut.

8. Peel back the CWC off the pipe carefully to ensure that the corrosion coating is not damaged.

The Seller furnishes any information contained herein without charge and assumes no obligation or liability for the advice given or the results obtained.
Rock Jacket®

Product Description
Rock Jacket® is a plant applied, fully bendable, reinforced concrete coating that was exclusively developed to offer mechanical protection to the anti-corrosion coatings of steel pipe in rocky terrain configurations as well as in road and river crossings. This coating system was designed to enable pipe to be buried directly in a blasted out rock trenches without having to incur the costs associated with surplus rock removal, sand padding backfill or additional mechanical padding.

Unique Mechanical Protection
Rock Jacket® offers superior long-term mechanical protection by reducing or eliminating damage due to handling, transportation, field stringing, bending, backfilling, and in-service use, thus significantly reducing repair costs to the anti-corrosion coating.

Design and Installation Flexibility
Rock Jacket® is the only mechanical protection system in the industry that has no limitations in terms of terrain configuration, trench material type and climate. It has also proven to be bendable to the requirements of all standard construction specifications without any non-standard equipment or additional effort on the contractor's side other than the use of oversized shoes and die on the bending machines for large diameters.

Excellent Compatibility
Rock Jacket® is wholly compatible with any Shaw coating system and does not affect the operating temperatures of these coatings. This ensures that the most appropriate weight coating system is selected without compromising the long-term corrosion protection or flow assurance of the pipeline.
Features & Benefits
- Rock Jacket® can be manufactured with a bend relief configuration, which allows for field bending up to 1.5°/pipe diameter, or manufactured to a non-bendable specification, for applications such as road/river crossings where no field bending is required.

- Rock Jacket Coating system does not compromise the cathodic protection system of the pipeline.

- Shaw has developed a calculator to provide a means to fairly assess the optimum method for pipe protection for pipeline projects on the basis of a total installed cost, rather than the net cost of the pipe protection method.

Compliancy
- Quality System Compliant to ISO 9001:2008

Standard Cutbacks
- 305 +25/-0mm
Repairs Using Grout Kit

- Apply tape on both sides of damaged area, to prevent plastic wrap from unraveling.

- Cut away plastic wrap to expose damaged area.

- Carefully remove sufficient material to expose wire. Ensure wire position is within specification. Adjust accordingly by cutting wire and tightening or loosening.

- A mold (or cast) of thick polyethylene such as 1500 micrometers (60 mils) is wrapped around pipe over the damaged area. Mold is extended approximately 150mm (6”) past the damaged area. Mold is overlapped 75mm (3”) around pipe.

- Tape is secured to mold on pipe*.

- Cut a 50 mm x 150 mm (2” x 6”) hole in top of mold in center of damaged area.

- Mix grout (available in both a summer and winter grade) to a pour-able consistency.

- Pour grout into hole, ensuring hole is completely filled.

- Cover hole with tape.

- Once repair has sufficiently cured, plastic is removed, and area is re-taped.

*When a repair is required at the end of the joint, a material with equal thickness to the coating shall be secured on the end of the pipe to support the mold.
**Recommended Procedures for Tie-Ins**

Rock Jacket® coated pipe that requires cutting during tie-ins should be cut with a heavy-duty circular saw fitted with a depth guide and a masonry blade using the following procedure:

1. Set up depth guide to ¾ of Rock Jacket® thickness, maximum (this setting should be rechecked frequently).

2. Align a guide at a point sufficiently back and parallel to the proposed tie-in to allow for the bevel cutting equipment; place the cutting equipment next to this guide. The guide can be a steel band or a guided masonry saw.

3. Cut the Rock Jacket® circumferentially completely around the pipe, parallel to the proposed tie-in.

4. Move cutting equipment to a point on the other side of the proposed tie-in to allow for the bevel cutting equipment, or the length that is required to cut pipe.

5. Cut the Rock Jacket® circumferentially completely around the pipe, parallel to the proposed tie-in.

6. After the circumferential cuts are completed, cut the Rock Jacket® longitudinally at 90°, 180°, 270° and 360°, to the distance corresponding to the Rock Jacket® that is to be removed.

7. After all cuts are completed spread all cuts with a dull rubber-tipped instrument to ensure that all the wire has been cut.

8. Peel back the Rock Jacket® off the pipe carefully to ensure that the corrosion coating is not damaged.

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