International Congress
of Corrosion, Integrity, Painting
and Corrosion Protection

CENTRO
DE TREINAMENTO
E QUALIFICAÇÃO
FERNANDO FRAGATA

Pipeclad® 2060 MRO
Próxima geração de FBE- Resistência avançada contra danos e umidade para tubos de aço.

Apresentação:
Márcia M Freire Oliveira
Dr. Jeffrey Rogosinski

SHERWIN WILLIAMS®

What is FBE?

Fusion Bonded Epoxy (Epóxi curado termicamente)

Powder

Liquid Bi-component

Mono component/minimizes cost with CP/Excellent Chemicall, Flexibility, corrosion and abrasion resistance/Easy Repair /Fast cure

Márcia M. Freire

BDM –Pipes/ W&WW Brasil

Engenheira Química:

- 18 anos de experiência em pintura e revestimento
- NACE CIP level II
- ABRACO IPNII SNQC

Jeff Rogozinski

Diretor Global -Produto FBE

Dr. Química/ Professor

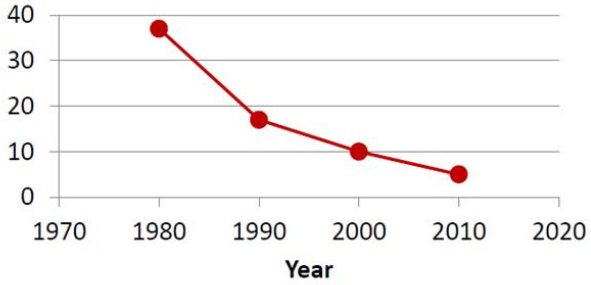
Leadership & Membership:

- **ISO 21809** (-1)(-2)(-3)(-4)(-5)(-6)
  - President of ISO21809-2 & ISO21809-6
  - USA SME Member of (-1) (-3) (-4) (-5)
- **NACE SP0394**
- **API 5L2 / API 5L7**
- **ASTM A775**
- **ASTM A934**

What is FBE?

Evolution of technology over the Years

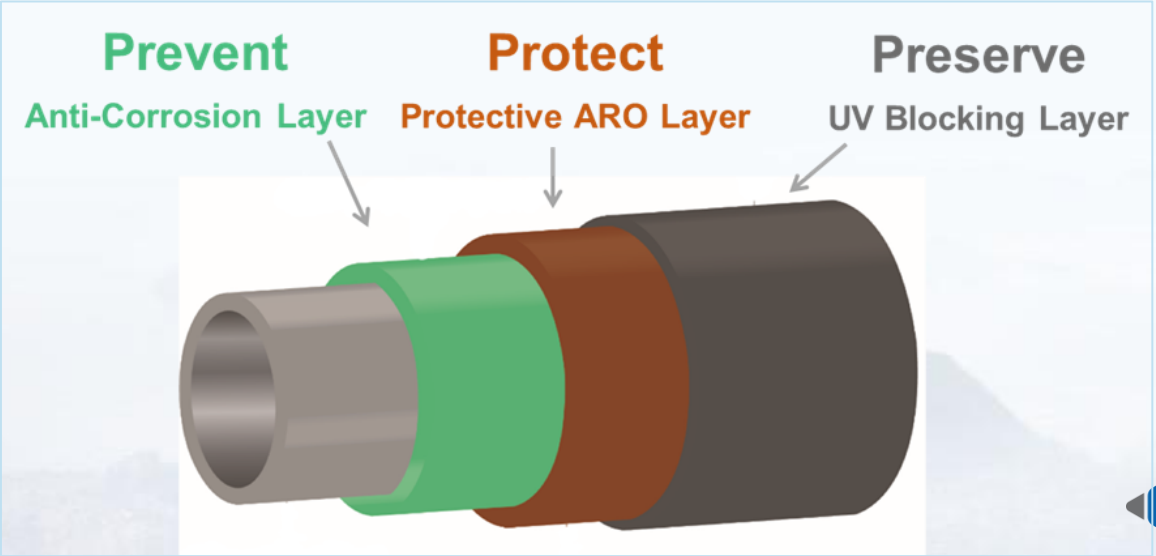
Disbondment (mm) from 65 °C, 28-day test at -1.5 V



Moisture Resistant Overcoat (MRO)

The Three Ps:
Prevent – Protect – Preserve

- Building pipeline performance, one layer at a time
- Families of products to suit end user requirements

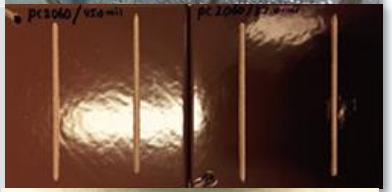


Moisture Resistant Overcoat (MRO)

Strong moisture-resistance + **Strong** damage tolerance + **High** flexibility

Moisture Resistance

Damage Tolerance

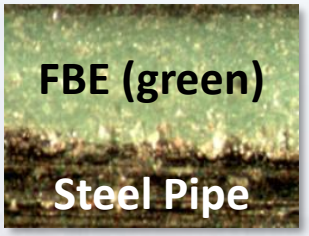


Flexibility

Combines the barrier attributes of historic high operating temperature systems with advanced ARO (abrasion resistant overcoat) technology

Comparison of FBE Based Systems

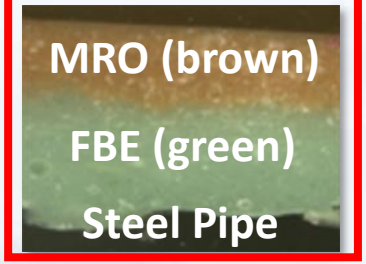
Standard Single-Layer 16-20 mils (400-500µ)



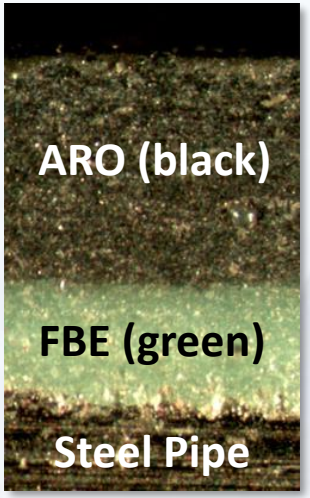
12/12 Dual-Layer 20-28 mils (500-700µ)

Applied as a system
Standard FBE
12 ± 2 mils
(250-350µ)

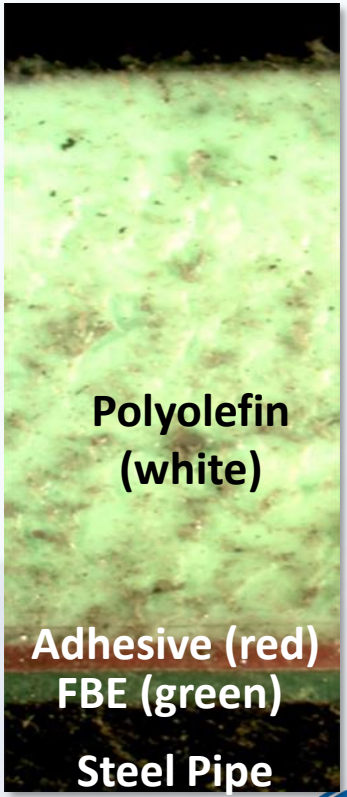
FBE MRO
12 ± 2 mils
(250-350µ)



Standard Dual-Layer 40-60 mils (1000-1500µ)



Standard 3-Layer 70-150 mils (1750-3800µ)



Moisture Resistant Overcoat (MRO) Attributes

MRO Abrasion-Resistant Overcoat comparison ARO

Dual Layer System	Application	Innovation	Protection	Temperatures
Applied as a dual layer powder system that provides an extremely robust protective coating to the outside of pipes.	Designed to be applied over fusion bonded epoxy (FBE) coatings on the exterior of pipes.	Features an innovation that provides superior protection against moisture and corrosive elements in the environment, while also providing abrasion resistance surpassing typical ARO coatings.	Provides optimum protection for the corrosion protection layer against both moisture uptake, as well as damage throughout storage, transit, construction and service of the pipeline, including during horizontal directional drilling and backfilling.	FBE MRO is designed for service temperatures up to **150°C** or higher dependent upon the base layer of corrosion protection which is applied.

MROs – Benefits of 12/12 mils (250/250m) System

APPLICATION	PERFORMANCE
• **Faster throughput** (applies at single layer speeds) • **Fewer holidays** "on the rack" • **Superior damage resistance** for handling and storage	• **Improved moisture barrier** – less "steam jacking" in HOT systems

INSTALLATION

- **Improved damage tolerance** (gouge, impact, tabor abrasion), reduced DCVG detectable holidays after backfill
- **Reduces installation cost** (less field repairs because of reduced mechanical damage, reduce the amount of padding required during pipeline installation)
- **Higher intrinsic dielectric strength** – fewer "false positive holidays" on right of way
- **More cost-effective field joints** compared to three-layer systems
- Field joints coated with same dual powder system maintain **coating integrity of entire pipeline**

Moisture Resistant Overcoat (MRO)

Application Characteristics:

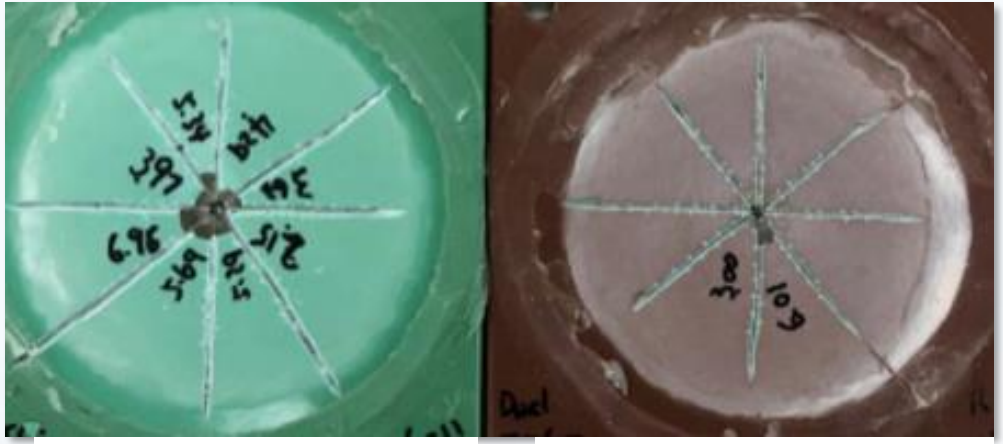
- At single layer speed
- Utilizes existing equipment
  - Same application booths as dual layer
  - Final DFT
    - ✓ 12 mils (300μ) Standard FBE SW
    - ✓ 12 mils (300μ) FBE MRO SW

High Performance

Exceptional Cathodic Disbondment Resistance: 56 days @ 65°C

Long-term Performance:

- Elevated temperature, long duration CDT testing
- Illustrates demonstrable improvement versus similar thickness FBE without the MRO
- Lower water vapor transmission rates



FBE alone 20 mils (500µ)

FBE/MRO @ 10/10 mils (250/250µ)

Moisture Resistant Overcoat (MRO)

95°C Hot Water Soak, 90 Days

Long-term Performance:

- Superior performance in long term wet conditions

Moisture Resistant Overcoat (MRO)

Damage Tolerance:

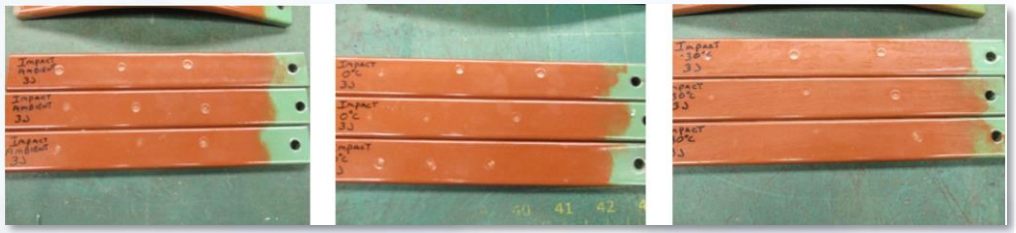
- 20-24mils (500-600μ)
- Flexibility over 3°/pd at -30°C
- Impact at over 3J at -30°C

3°/pd @ -30°C

Sample	Mandrel	Coating Thickness	Result (Pass/Fail)
1	5.75	20-22 mils	No cracking: Pass
2	5.75	21-24 mils	No cracking: Pass
3	5.75	22-23 mils	No cracking: Pass

Impact Testing

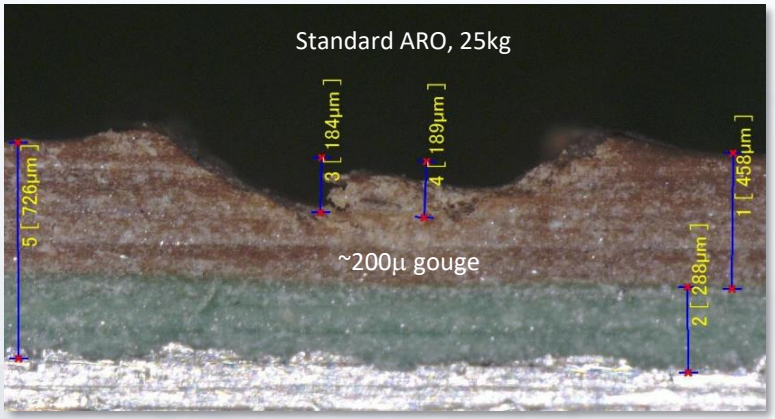
Temperature	Impact Joules	# of Specimens	Holiday Detection	Result (Pass/Fail)
Ambient (25°C)	3.0 Joules	3	No holidays	Pass
0°C	3.0 Joules	3	No holidays	Pass
-30°C	3.0 Joules	3	No holidays	Pass

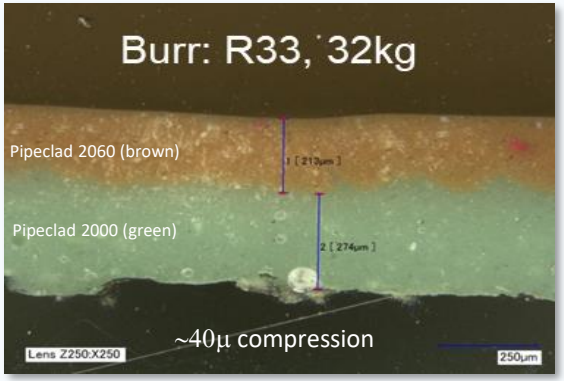


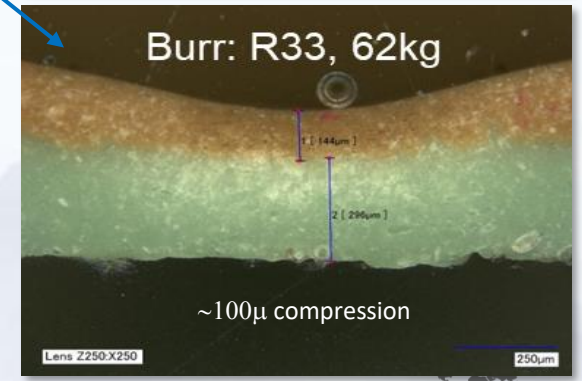
Moisture Resistant Overcoat (MRO)

Damage Tolerance:

- Over 50% better gouge resistance than standard ARO
- Illustrates “compressive” behavior for HDD applications
- 30% less tabor abrasion mass loss than standard ARO







Moisture Resistant Overcoat (MRO)

Backfill Drop Test:

- Raised rocks 10ft (3m) above pipe
- ~3in (~7.6cm) aperture
- Let them drop

Field Testing: Del Rio, Texas

Moisture Resistant Overcoat (MRO)

Backfill Drop Test:

- Appeared as if there were holidays, however…

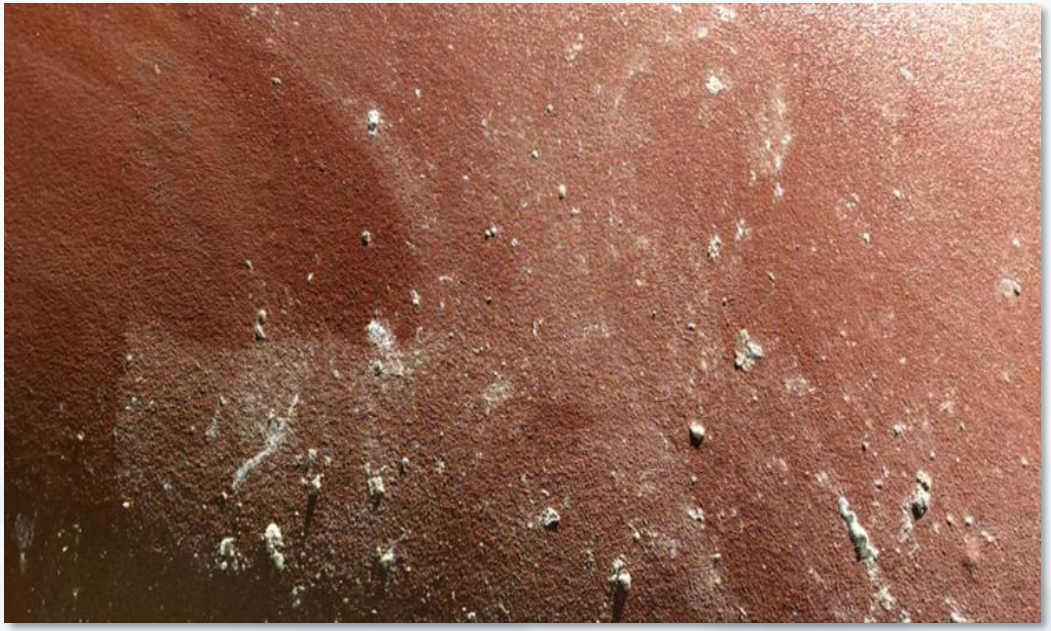
Field Testing: Del Rio, Texas

Moisture Resistant Overcoat (MRO)

Backfill Drop Test:

- Hand wiped away “pulverized” rock dust
- No holidays (NACE SP01888 @ 3000V)
  - 12 mils (300μ) FBE
  - 12 mils (300μ) MRO

Field Testing: Del Rio, Texas



Moisture Resistant Overcoat (MRO)

Field Flexibility Test:

- “Wrinkled” the pipe
- No cracks or holidays (NACE SP01888 @ 3000V)
  - 12 mils (300μ) FBE
  - 12 mils (300μ) MRO

Field Testing: Del Rio, Texas

Moisture Resistant Overcoat (MRO)

Improved Dielectric Properties:

- Less moisture uptake
- Fewer issues with wet/dry sponge holiday detection (fewer “false positives”)

Moisture Resistant Overcoat (MRO)

Whistler Project, Southwest Texas, USA

Moisture Resistant Overcoat (MRO)

Recent Update to Federal Regulations

49 CFR 192.461 (up to date as of 5/26/2023)
External corrosion control: Protective coating.

49 CFR 192.461 (2023-05-26)

This content is from the eCFR and is authoritative but unofficial.

Title 49 —Transportation
Subtitle B —Other Regulations Relating to Transportation
Chapter I —Pipeline and Hazardous Materials Safety Administration, Department of Transportation
Subchapter D —Pipeline Safety
Part 192 —Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
Subpart I —Requirements for Corrosion Control

Source: Amdt. 192–4, 36 FR 12302, June 30, 1971, unless otherwise noted.
Authority: 30 U.S.C. 185(w)(3), 49 U.S.C. 5103, 60101 *et. seq.*, and 49 CFR 1.97.
Source: 35 FR 13257, Aug. 19, 1970, unless otherwise noted.

Editorial Note: Nomenclature changes to part 192 appear at 71 FR 33406, June 9, 2006.

Moisture Resistant Overcoat (MRO)

§ 192.461 External corrosion control: Protective coating.

(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 underfilm migration of moisture;

(3) Be sufficiently ductile to resist cracking;

(4) Have sufficient strength to resist damage due to handling (including, but not limited to, transportation, installation, boring, and backfilling) 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.

(f) Promptly after the backfill of an onshore steel transmission pipeline ditch following repair or replacement (if the repair or replacement results in 1,000 feet or more of backfill length along the pipeline), but no later than 6 months after the backfill, the operator must perform an assessment to assess any coating damage and ensure integrity of the coating using direct current voltage gradient (DCVG), alternating current voltage gradient (ACVG), or other technology that provides comparable information about the integrity of the coating. Coating surveys must be conducted, except in locations where effective coating surveys are precluded by geographical, technical, or safety reasons.

(g) An operator must notify PHMSA in accordance with § 192.18 at least 90 days in advance of using other technology to assess integrity of the coating under paragraph (f) of this section.

(h) An operator of an onshore steel transmission pipeline must develop a remedial action plan and apply for any necessary permits within 6 months of completing the assessment that identified the deficiency. The operator must repair any coating damage classified as severe (voltage drop greater than 60 percent for DCVG or 70 dBμV for ACVG) in accordance with section 4 of NACE SP0502 (incorporated by reference, *see* § 192.7) within 6 months of the assessment, or as soon as practicable after obtaining necessary permits, not to exceed 6 months after the receipt of permits.

(i) An operator of an onshore steel transmission pipeline must make and retain for the life of the pipeline records documenting the coating assessment findings and remedial actions performed under paragraphs (f) through (h) of this section.

[Amdt. 192–4, 36 FR 12302, June 30, 1971, as amended by Amdt. 192–132, 87 FR 52268, Aug. 24, 2022]

FBE MRO SW system meets key attributes

- Moisture Resistance
- Flexibility
- Impact and Gouge resistance
- Synergistic with cathodic protection
- Low Moisture Uptake and High Dielectric Strength

Moisture Resistant Overcoat (MRO)

Applicator Testimonial

Good afternoon,

We recently ran your new MRO powder for a test run to see how it would perform. All testing passed well within specifications. The two things that really stood out were impact and flexibility. We were able to bend straps up to 3.5° per pipe diameter without any cracking or disbondment. We were able to do an impact from as high as our apparatus would go (which is about 4 feet) without any holidays being created.

Below is some information on what our parameters were when coating using this powder:

- *Pipe OD: 10”*
- *Pipe wall: .375”*
- *Line Speed: 42 feet per minute*
- *Coating temperature: 467°-471°F*
- *Millage: 26-30 overall; split: 12-14 FBE; 15 -18 MRO*

Feel free to contact me if you need any further information or have any questions concerning our recent run. Thank you.

Moisture Resistant Overcoat (MRO)

Award Winning

Pipeline & Gas Journal Awards

Best Coating/Corrosion Advancement Technology

TOP PROJECTS

Journal of Protective Coating and Linings (JPCL)
Top Projects for Steel Coatings

WHISTLER PIPELINE PROJECT

PROJECT LOCATION: PERMIAN BASIN, TEXAS

CLIENT/OWNER: WHITEWATER MIDSTREAM, LLC (AUSTIN, TEXAS)

CONTRACTOR: STUPP COATINGS (BATON ROUGE, LOUISIANA)

COATINGS SUPPLIER: SHERWIN-WILLIAMS PROTECTIVE & MARINE (CLEVELAND)

Cipra 2023 CTOff.org

Comparison TDS ARO X MRO

Standard ARO

PERFORMANCE CHARACTERISTICS

Test Name	Test Method		Results
Cathodic Disbondment	CSA Z245.20 Section 12.8	24 hours, -3.5V, 65°C	2.1 mm avg.
		48 hours, -1.5V, 65°C	1.2 mm avg.
		28 days, -1.5V, 80°C	6.1 mm avg.
Cathodic Disbondment (Strained Coating)	CSA Z245.20 Section 12.13, 28 days, -1.5V, 20°C, 1.5°/PD		No cracking
Dielectric Strength	ASTM D149, Breakdown Voltage		>600V/mil
Flexibility	CSA Z245.20 Section 12.11, fixed mandrel bend, -30°C		>2.5° per pipe diameter length
Gouge Resistance	CSA Z245.20 Section 12.15, 50kg		11% at -30°C 25% at 50°C
Hardness	ASTM D2240, Shore D		86
Hot Water Resistance	CSA Z245.20 Section 12.14	24 hours, 75°C	1 Rating
		28 days, 75°C	1 Rating
Impact Resistance	CSA Z245.20 Section 12.12, 16 mm ball, 3.0J, -30°C		No holidays
Porosity	CSA Z245.20 Section 12.10, Cross Section		1 Rating
Volume Resistivity	ASTM D257, Through film, 500V		>1.0 x 10^{14} ohm-cm
Yield Strength	ASTM D2370, Tensile Test		>7,200 psi

FBE MRO

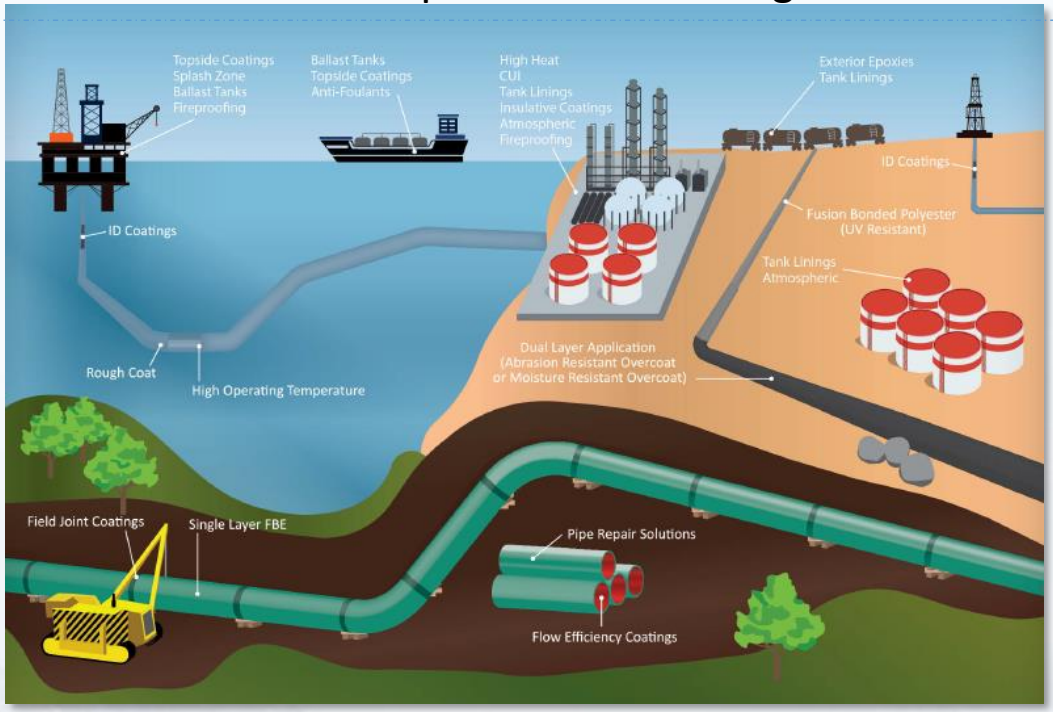
PERFORMANCE CHARACTERISTICS

Test Name	Test Method		Results
Abrasion Resistance	ASTM D4060, Taber, CS-17, 1000 cycles		<35 mg
Cathodic Disbondment, over Pipeclad 2000	CSA Z245.20 Section 12.8	28 days, -1.5V, 20°C	2.7 mm avg.
		28 days, -1.5V, 65°C	2.2 mm avg.
		7 days, -1.5V, 85°C	1.5 mm avg.
		14 days, -1.5V, 113°C	3.0 mm avg.
		14 days, -1.5V, 130°C	2.2 mm avg.
		28 days, -1.5V, 130°C	3.5 mm avg.
Cathodic Disbondment (Strained Coating)	CSA Z245.20 Section 12.13, 28 days, -1.5V, 20°C, 1.5°/PD		No cracking
Dielectric Strength	ASTM D149, Breakdown Voltage		>600V/mil
Flexibility	CSA Z245.20 Section 12.11, fixed mandrel bend, -30°C		>2.5° per pipe diameter length
Gouge Resistance	CSA Z245.20 Section 12.15, 30kg		<65, SL-1 Burr <23, R33 Burr
Hot Water Resistance	CSA Z245.20 Section 12.14	24 hours, 75°C	1 Rating
		28 days, 75°C	1 Rating
Impact Resistance	CSA Z245.20 Section 12.12, 16 mm ball, 3.0J, -30°C		No holidays
Porosity	CSA Z245.20 Section 12.10, Cross Section		1 Rating
Pull Off	ASTM D4541, PATTI		>4,000 psi
Volume Resistivity	ASTM D257, Through film, 500V		>1.0 x 10^{14} ohm-cm
Water Vapor Transmission Rate (WVTR)	ASTM D1653		<3 g/m^2-day
Yield Strength	ASTM D2370, Tensile Test		>7,200 psi

Fitting It All Together

From Exploration to Transportation:

Sherwin-Williams offers a full portfolio of coatings for the oil & gas market



Muito Obrigada !

Márcia M. Freire de Oliveira
BDM – Coord. de Desenvolvimento de Mercado – Pipe / Pulp&Paper / Water &Waste Water
Sherwin-Williams Protective & Marine Coatings
marcia.freire@sherwin.com.br
Cel: +55(19) 99606-5373