



Cold Temperature Research Results for Adhesives

Section 1: Understand the conditions of “cold” installation

Section 2: Understand what risks are associated

Section 3: Understand how JM conducted testing

Section 4: New installation recommendations from our learnings

Understand environmental conditions associated with a “cold” application



WHY IS THIS A CONSIDERATION?

- A wider window of installation below 40 °F provides longer roofing season
 - Early spring
 - Late fall
- Market information indicates 20% or greater of roofing systems are installed fully adhered – varies based on the membrane type
- Constrained labor market
- Competitive market pushes for added value in the offering
- Provides building owner confidence

WHAT IS COLD?



- Most roofing industry recommendations identify the transition to cold temperatures below 40°F
- Historical language communicated acceptable installation when roof top environment met 40°F and rising
- Dedicated formulations are now in the market touting better mixing and application characteristics in “cold” conditions

WHICH ADHESIVES ARE CONSIDERED?

- Non-exempt solvent systems
- Low VOC solvent systems



Water based systems

- No reasonable change will keep water from freezing
- 40°F and rising
- Check the Roof TechXpert App

What risks are associated with applying solvent based adhesives below 40°F?



WHAT MAY HAPPEN?



Flash times are extended

Condensation

- Installed too quickly results in:
- Blisters
 - Decreased bonding strength



- Adhesive stored on the job site will drop in temperature
- Substrates, membrane, application equipment will pull heat out of the adhesive
- Liquids increase in viscosity as temperature drops
 - This impacts multiple areas
 - Additional work is necessary to spread the product
 - Will the adhesive pool, clump, flow?
 - Results in higher probability of the risks identified on prior slide

Understand how the adhesives were tested to quantify the critical performance



- December 22, 2016 7:00 AM-11:00 AM, Littleton, CO.
- Parking lot with building covering N exposure (no direct sunlight).
Temp: 23°F and RH: 71%



- Varied degrees of blistering/delamination observed
- Varied levels of bond quality in the adhesives
- Better environmental controls are necessary for quantitative evaluation
- Adhesive temperatures in the buckets dropped
 - Where is the temperature threshold that impacts performance?
 - Will cold substrates influence bond quality?

These samples were not rolled with a weighted roll – Did the build quality influence our results?

- Johns Manville's technical center has a cold chamber!
- Conditioned all materials (ISO, membrane, ...)
- Conditioned adhesive
- Built large scale samples for blister/delamination
- Built small scale peel samples for quantitative results
- Decreased the adhesive temperature under control
- Rolled all builds to mimic the field installation

The temperature of the cold spray booth was set @ 25°F. The average substrate and TPO temp ranges are from 23.4 to 27.7°F.

Target Adhesive Temp	RT (F)	35(F)	30(F)	25(F)	20(F)
Actual Temp/SB Adhesive	62.1	34.3	30.1	24.7	19.1
Actual Temp/LVOC Adhesive	61.0	33.9	29.9	25.4	18.6

- 2'x2' ISO & TPO membrane
- 2"x6" peel samples over OSB
- Varied conditioning prior to testing
- Solvent and Low VOC adhesives evaluated

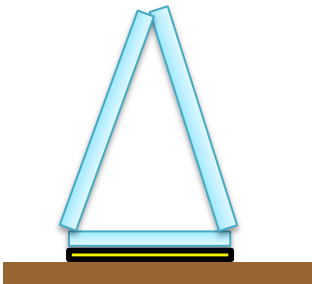
Top view



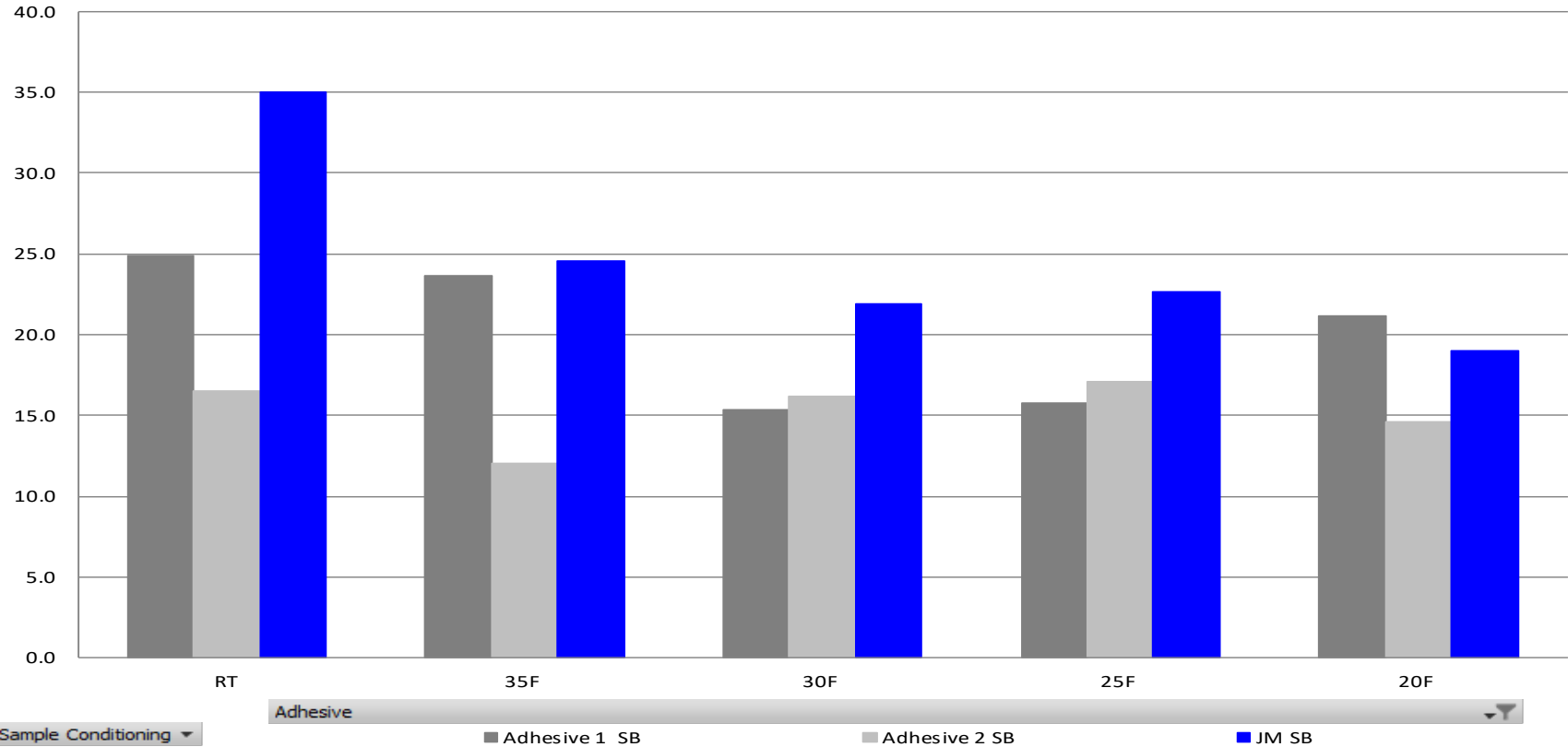
Side view



Peel



SB Adhesive Peel Test Results



2"x6" SMALL SCALE SOLVENT SAMPLES

Sample IDs	SB-RT	SB-20F
JM Adhesive	 A photograph of a 2"x6" OSB sample labeled 'JM-SB-RT'. The sample is split vertically. The left half is the natural light-colored OSB, and the right half is coated with a dark, thick adhesive layer.	 A photograph of a 2"x6" OSB sample labeled 'JM-SB-20F'. The sample is split vertically. The left half is the natural light-colored OSB, and the right half is coated with a dark, thick adhesive layer.
Adhesive 1	 A photograph of a 2"x6" OSB sample labeled 'SB-RT' with 'Cold Store' written on it. A rectangular area is outlined in black. The sample is split vertically, with the right half coated in dark adhesive.	 A photograph of a 2"x6" OSB sample labeled 'SB-20F'. Two rectangular areas are outlined in black. The sample is split vertically, with the right half coated in dark adhesive.
Adhesive 2	 A photograph of a 2"x6" OSB sample labeled 'SB-RT'. A rectangular area is outlined in black. The sample is split vertically, with the right half coated in a grey, textured adhesive.	 A photograph of a 2"x6" OSB sample labeled 'SB-20F'. A rectangular area is outlined in black. The sample is split vertically, with the right half coated in a grey, textured adhesive.

2'x2' SOLVENT SAMPLES INSTALLED 20°F

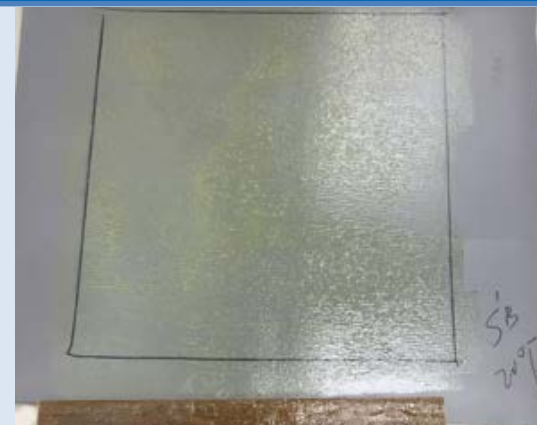
JM Adhesive



Adhesive 1

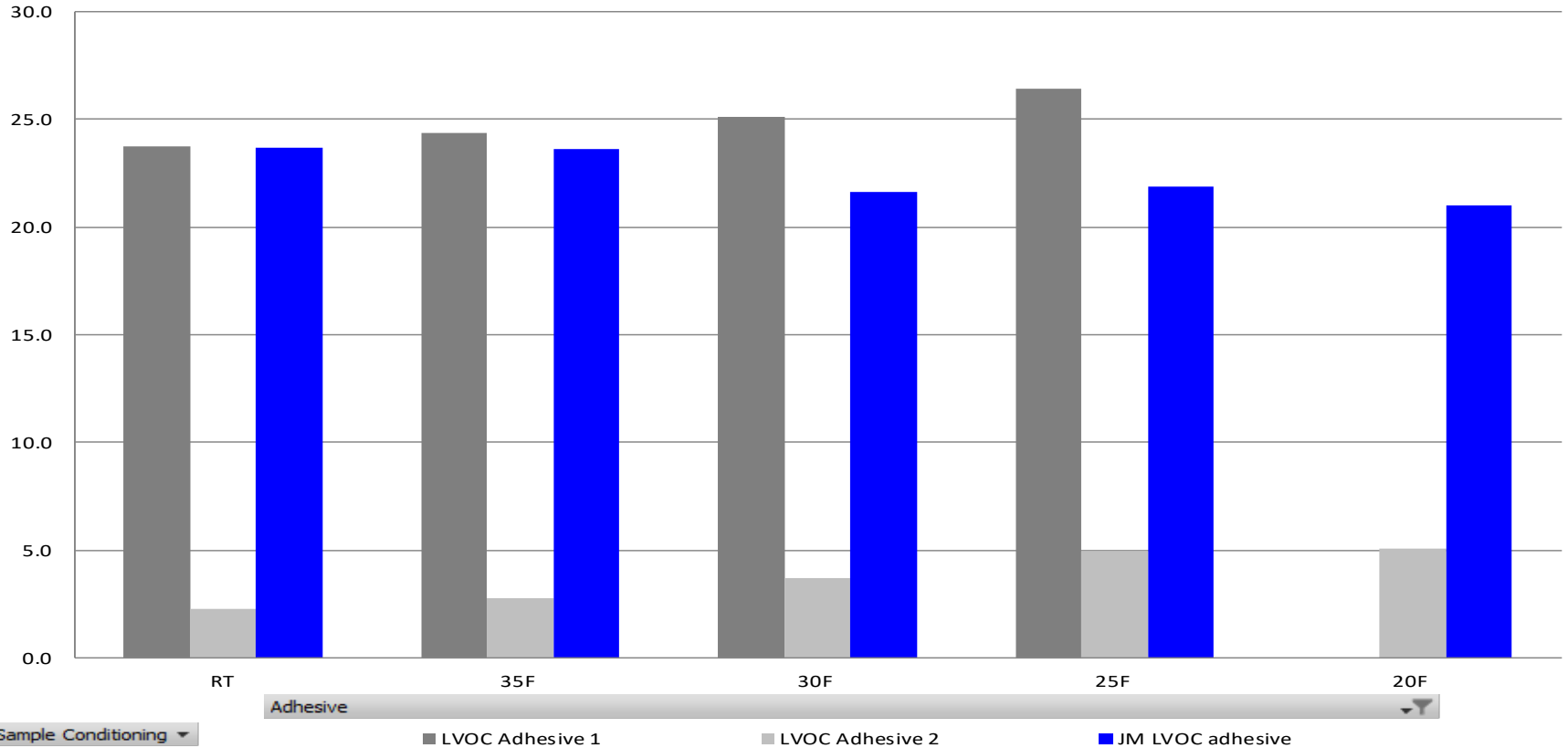


Adhesive 2



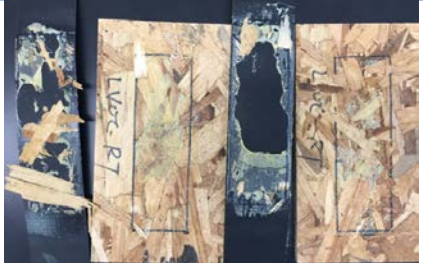





- Peel strength decreases as adhesive temperature drops
- JM and adhesive 1 achieve cohesive failure in small scale testing to temperatures as low as 20°F
- Blistering and delamination are not present in the 2'x2'

Low VOC Adhesive Peel Test Results



2"x6" SMALL SCALE LOW VOC SAMPLES

Sample IDs	Low VOC-RT	Low VOC-20F
JM Adhesive		
Adhesive 1		
Adhesive 2		

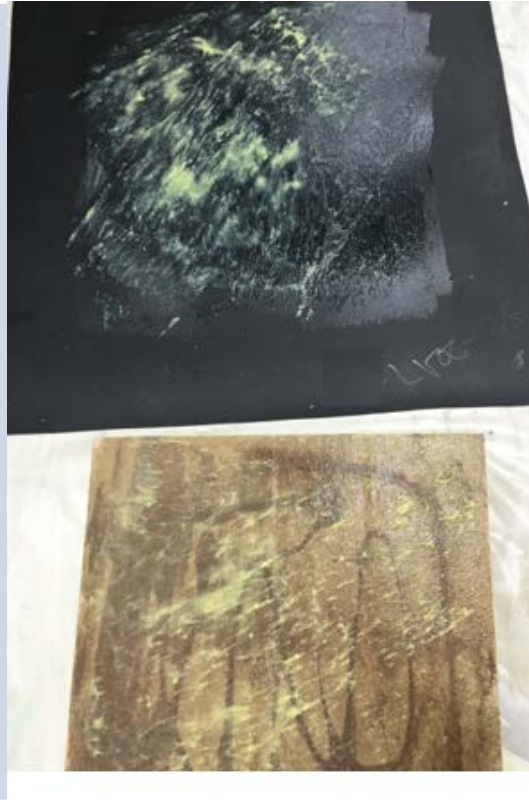
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PICTURES OF 2"x2" SAMPLES AT 25°F

JM Low VOC Adhesive

Low VOC Adhesive 1

Low VOC Adhesive 2



LOW VOC BASED ADHESIVE FINDINGS

- Peel strength is more stable than the solvent based formulations
- JM and adhesive 1 achieve cohesive failure in small scale testing to temperatures as low as 25°F
- Blistering and delamination are not present in the 2'x2'
- Adhesive 1 and Adhesive 2 will not spread evenly at 25°F
- Adhesive 1 gels at 20°F and could not be tested for peel performance

JM's Low VOC rules performance at 20°F

- The old recommendations of 40 °F and rising is more restrictive than current adhesive performance

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TPO Roofing Systems

Commercial Roofing Application Guide

JM Johns Manville

JM LVOC Membrane Adhesive (TPO & EPDM)

Features and Components

Use: For adhering JM TPO and JM EPDM membranes to approved substrates. Do not use on fleece-backed membranes at any time.

Type: One-part, low VOC synthetic polymer-based membrane adhesive.

Substrate: Compatible with approved insulations and cover boards, wood substrates, concrete, and light-weight concrete decks.

Color: Yellow

System Compatibility This product may be used as a component in the following system. Please reference product guidelines for specific installation methods and information.

System	TPO	EPDM
1	✓	✓

Do not use in Multi-Ply systems

Use to adhere Membranes in the selected Single Ply system above

Key: NA = Not Applied CA = Cold Applied HW = Heat Weldable SA = Self Adhered MF = Mechanically Fastened RA = Fully Adhered BA = Ballasted

Energy and the Environment

Maximum VOC: <math>< 250 \text{ g/l (EPA Method 24)}</math>

This product may be used in jurisdictions limiting VOC volatile organic compounds content of single ply roofing adhesives to no greater than 250 g/l, Net 100 Totalpot.

Physical Properties

Property	JM LVOC Membrane Adhesive
Weight per Unit Volume	7.8 kg/m ³ (50 kg/m ³)
Specific Gravity	0.9

Precautions

This product is flammable. Adhesive contains ingredients which could be harmful if inhaled. Contact with skin and eyes should be avoided, and the recommended personal protective equipment should be worn.

Installation/Application

- Apply when ambient and substrate temperature is 40°F (4°C) and rising.
- Typically used in SMP systems as a bonding adhesive.
- Do not use for splicing. Do not apply adhesive near seams or laps, or where a hot air welder will be used.
- Do Not Test. Refer to the application instructions guidelines for proper utilization of this adhesive.

Packaging and Coverage

Property	Value
Container Size	5 gal (18.9 gal)
Shipping Weight (approx.)	42 lb (19.1 kg)
Coverage Rate*	50 - 60 ft ² /gal (1.0 - 1.22 m ² /gal)

*Coverage, open and dry film rates can vary substantially depending on the particular substrate and environmental conditions. Coverage rates also vary with application method. EPDM (SMP or P) Adhesives is required, consult specific methods on the UCC Certificates website for more information.

Storage

Property	Value
Shelf Life	12 months from manufacture date
Storage Conditions	Clean, dry indoor environment in an unopened container
Temperature Range	40°F - 80°F (4°C - 27°C). Protect from freezing

Exposure Window

Johns Manville recommends immediate and complete use upon opening. Use open containers within 48 hours of opening. Replace lid on can when not in use. Adhesive that has changed color or viscosity is no longer usable.

Refer to the Safety Data Sheet and product label prior to using this product. The Safety Data Sheet is available by calling (800) 923-6622 or on the Web at www.jm.com/roofing.

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JM MEMBRANE BONDING ADHESIVE (TPO & EPDM)

Features and Components

Use: For adhering JM TPO and EPDM membranes to approved substrates. Do not use on fleece-backed membranes.

Type: One-part, synthetic polymer-based membrane adhesive, two-sided application.

Substrate: Compatible with insulation board, metal, wood and other decking materials.

Color: Yellow

System Compatibility This product may be used as a component in the following system. Please reference product guidelines for specific installation methods and information.

System	TPO	EPDM
1	✓	✓

Do not use in Multi-Ply systems

Use to adhere Membranes in the selected Single Ply system above

Key: NA = Not Applied CA = Cold Applied HW = Heat Weldable SA = Self Adhered MF = Mechanically Fastened RA = Fully Adhered BA = Ballasted

Energy and the Environment

Maximum VOC: 880 g/l (EPA Method 24)

Physical Properties

Property	JM TPO Membrane Bonding Adhesive
Weight per Unit Volume	13.9 lb/gal (0.97 kg/l)
Specific Gravity	0.865 - 0.87

Precautions

This product is flammable. Adhesive contains ingredients which could be harmful if inhaled. Contact with skin and eyes should be avoided, and the recommended personal protective equipment should be worn.

Installation/Application

- Apply when the ambient and substrate temperature is 40°F (4°C) and rising.
- Do not use for splicing. Do not apply adhesive near seams or laps, or where a hot air welder or seam tool will be used.
- Do Not Test. Refer to the application instructions guidelines for proper utilization of this adhesive.

Packaging and Coverage

Property	Value
Container Size	5 gal (18.9 gal)
Shipping Weight (approx.)	35.5 lb (16.1 kg)
Coverage Rate* (2:1)	50 - 60 ft ² /gal (1.22 - 1.63 m ² /gal)

*Coverage, open and dry film rates can vary substantially depending on the particular substrate and environmental conditions. Coverage rates also vary with application method. EPDM (SMP or P) Adhesives is required, consult specific methods on the UCC Certificates website for more information.

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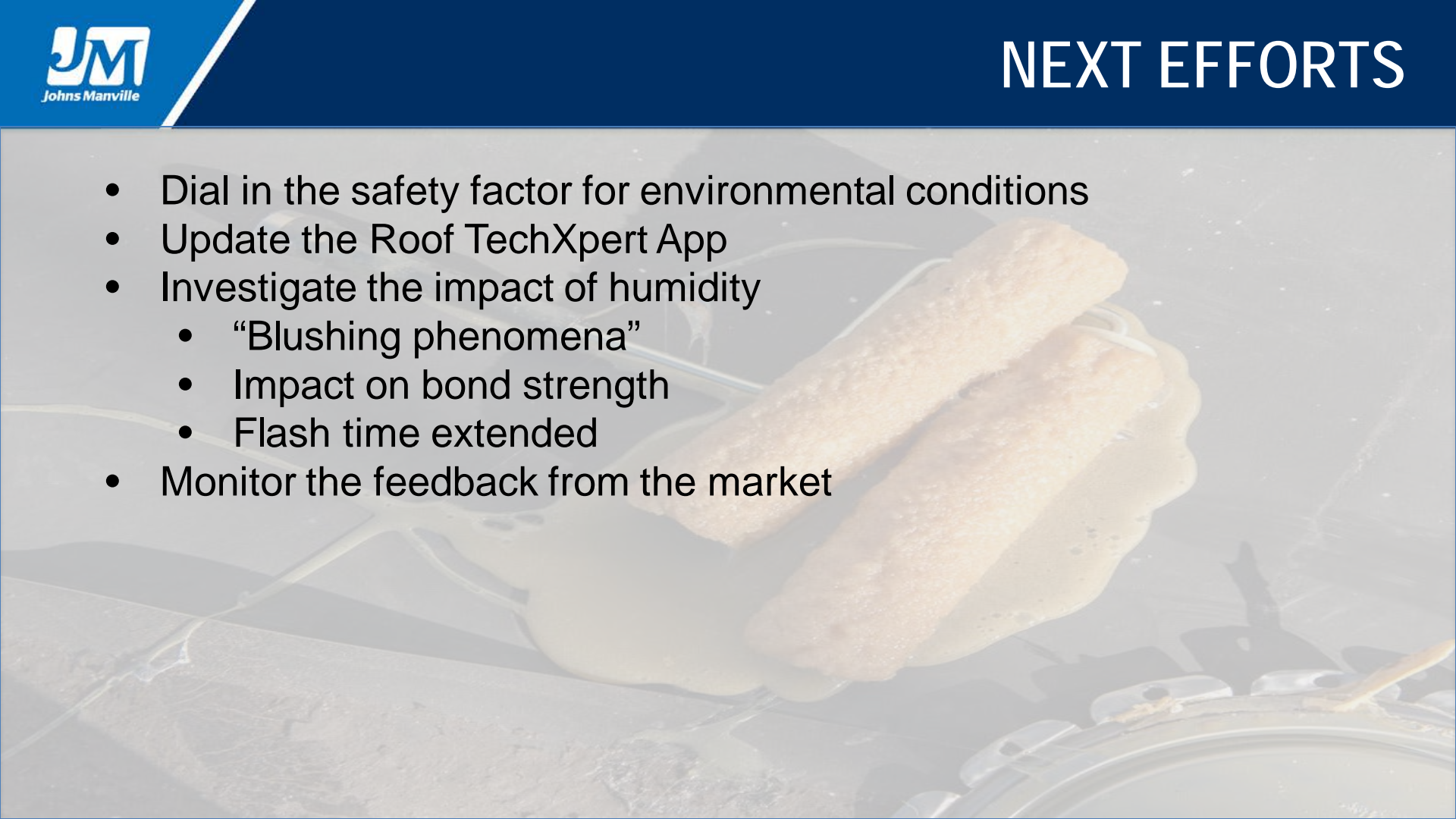
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Cold Weather Application

Solvent and Low VOC/Solvent-Based Adhesives Cautions below 40°F

- **JM Membrane Bonding Adhesive should NOT be applied**
 - When ambient temperatures are 25°F (-3.8°C) or colder.
 - Adhesive temperature is at/below 32°F (0°C).
 - Adhesive containers must be stored in a warming hut 60°F – 80°F (16°C - 27°C) when ambient temperatures are at or below 40°F (4.4°C).
 - Protect from freezing.
 - Opened adhesive being installed in cold weather applications that drops in temperature to the freezing point shall be restored to room temperature prior to continued use.
 - In high relative humidity or when the dew point is within 10 degrees of ambient temperature.

- Dial in the safety factor for environmental conditions
 - Update the Roof TechXpert App
 - Investigate the impact of humidity
 - “Blushing phenomena”
 - Impact on bond strength
 - Flash time extended
 - Monitor the feedback from the market
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- JM's solvent and Low VOC adhesives install and perform well when temperatures are below 40°F.
- Proper storage and preparation of adhesive, substrate and membrane are critical.
- Adhesive must be stored in a warming hut to ensure 60°F or greater temperature.
- Adhesive should not be applied if the bucket temperature gets below freezing.
- Substrates and environmental conditions must be 25°F and rising.
- Proper installation technics will prevent blistering.