The Dirt Pick-Up Resistance Battle

Coatings Trends & Technologies SUMMIT

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Dirt Pick-Up Resistance

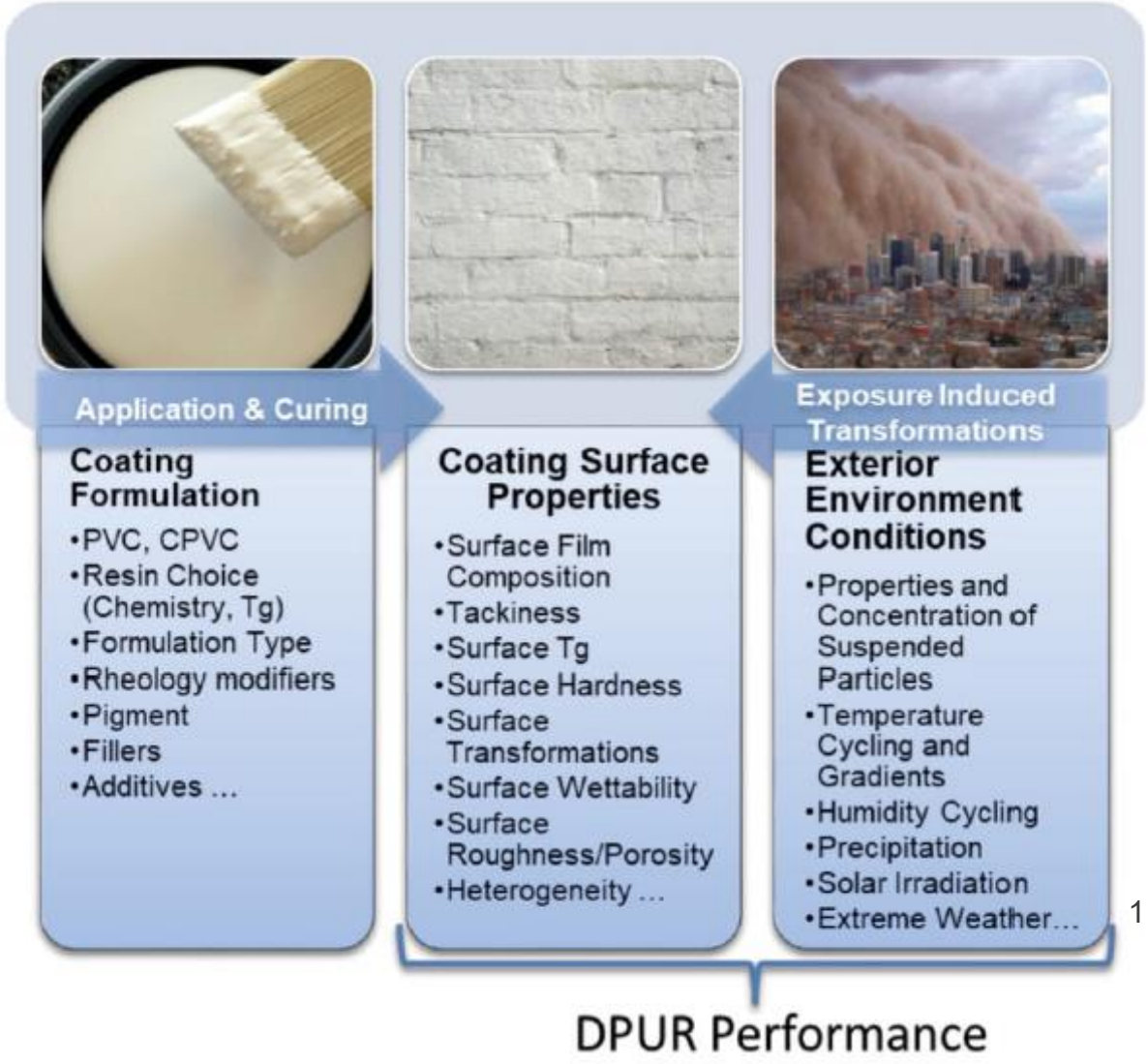
What is Dirt Pick-Up Resistance?

- Dirt pick-up resistance (DPUR) is a coating's ability to resist discoloration due to the deposition of particles from the environment.

Why is Dirt Pick-Up Resistance important?

- Aesthetics- Dirty buildings are not very attractive
- Potential Energy savings
  - Coatings which are white in color and cleaner reflect the sun better and can assist in keeping a building cooler
- Cost Containment - Saves money and time on cleaning and repainting
  - Some types of building stains or discoloration are only cosmetic, while others may indicate growths that could reduce coating service life such as on siding, or trim.

Factors Affecting Dirt Pick-Up Resistance



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Why is Better Dirt Pick-Up Resistance Needed?

- **Growth in the development of "softer" elastomeric wall and roof coatings**
  - In urban or industrial areas airborne dust is a persistent problem.
  - Continued construction of high-rise commercial buildings creating the need for coatings that are easier to clean and maintain.
  - In existing high-rise building exterior maintenance and cleaning represent the highest cost.

- **Market demand for low-VOC formulations**
  - Usually resulting in tackier coatings with worse dirt pick-up resistance
  - Environmental regulations throughout the U.S.
  - Third party certifications such as Green Seal

Improved dirt pick-up resistance will extend the paint service life

Accumulation of Dirt

The accumulation of dirt on a surface can be broken down into three events:

- Deposition of Dirt
- Adhesion and Entrenchment
- Shedding and Release[2]

Approaches to Winning the Battle Against Dirt

- Highly crosslinked polymers which could result in a low-tack surface
- High T_g polymers
- Multi-staged polymers
  - A mixture of polymers with different T_g ranges, resulting in a mix of hard and soft segments.
- Increasing the pigment volume concentration (PVC) thus creating a harder surface
- Photo-catalytic degradation agents
  - Emerged as a promising alternative for degradation of many organic pollutants
  - Caveat – can potentially degrade the latex as well.
- Hydrophobic coating technology
  - Water beads more readily, maintains a higher surface tension and keeps the water from plasticizing the film.

Test Methods

1. Accelerated Testing
2. Exterior Exposure

How is Dirt Pick-Up Resistance Measured?

- **Accelerated Testing**
  - Accelerated testing involves applying dirt standards (such as iron oxide slurries, carbon black slurries, or dry dirt particulate) to a coated panel. The panel is then evaluated for color change after the dirt is removed by washing, tapping, or wiping.

- **Examples**
  - UNI 10792- dry charts for 28 days, dip into black iron oxide solution, rinse, let dry 24 hours, measure Delta L (ΔL)
  - Chinese standard GB/T 9780-2013- Test method for dirt pick-up resistance and stain removal of film of architectural coatings and paint; fibre cement panels, local dirt
  - ASTM method is under development- the preliminary study used a brown iron oxide slurry on aluminum panels

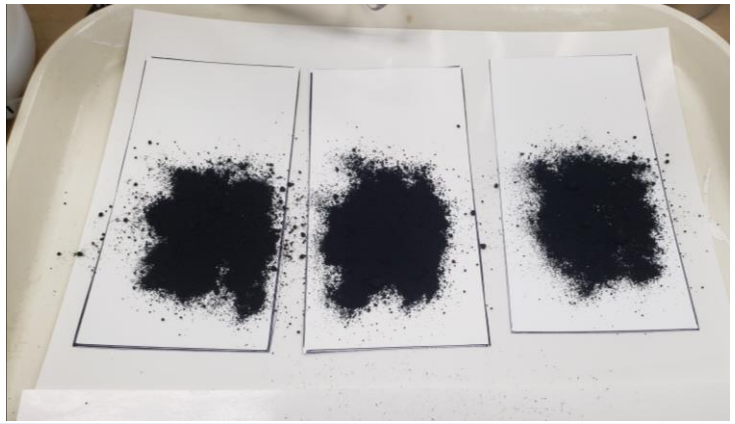
- **Exterior Exposure**
  - Measure color before putting panels outside.
  - Typical procedure is to place the panels on a South-facing test fence at a 45° angle.
  - Measure color periodically.

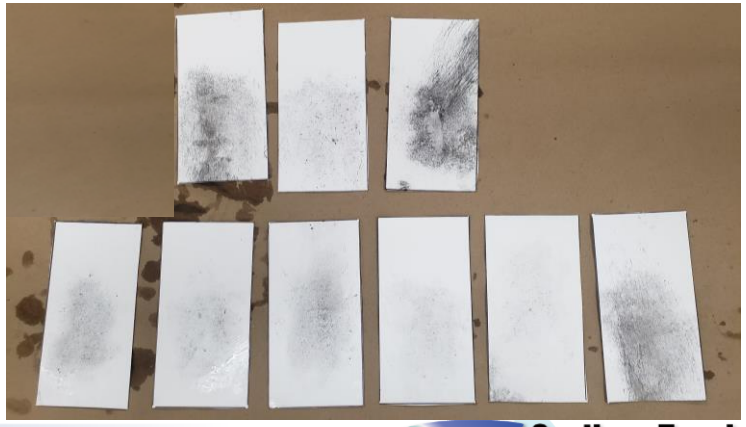
Accelerated Testing- Internal Method

- The paints were drawn down using a 20-mil film applicator onto black Leneta panels and cured for 7 days at room temperature.
- Each of the panels was checked for CIE L*a*b* values to set a baseline for paint whiteness, at which point iron oxide powder was poured onto the panels (below, left) and allowed to let stand for 1 hour at room temperature.
- The iron oxide powder was rinsed from the panels under flowing water for approximately 30 seconds, and the panels (below, right) allowed to dry for 3 days at room temperature.
- Each panel was re-tested for CIE L*a*b* values and the results compared to the initial lightness vales.

Left: Dirt pick-up panels with iron oxide powder applied

Right: Panels after rinsing. Commercial examples on top (Commercial Paints) and Synthomer on bottom. (L to R: 073A-073F)





Dirt Pick-Up: Results and Analysis

→ L* values of the paints were tested, with ΔL showing the change in L* from prior to dirt application to final reading.

→ The best performer was Latex 2. **All SC (Self-Crosslinking) latexes performed well.**

Formula	Latex	Chemistry	Latex MFFT (C)	ΔL*
18-100-073A	Latex 4	PA, SC	4	5.79
18-100-073B	Latex 5	PA	17	5.41
18-100-073C	Latex 3	PA	4	12.55
18-100-073D	Latex 6	PA, SC	5	5.90
18-100-073E	Latex 2	**PA, SC**	8	**4.13**
18-100-073F	Latex 3-3	PA Core-shell	0	21.85
Commercial Paint B	n/a	N/A	N/A	21.12
Commercial Paint C	n/a	N/A	N/A	8.55
Commercial Paint D	n/a	N/A	N/A	27.94

Accelerated Testing- Alternate Internal Method

- **Test Method**
  - Application of the paint at 12-mils wet film thickness
  - Drying protocol : 1 day at room temperature, 5 days of UV-B exposure, 1 day at room temperature
  - Application of a carbon black pigment on half of the panel with a brush
  - Removal of the pigment rubbing vigorously with a white tissue, until trace of black pigment has disappeared from the tissue
  - Measurement of color difference between soiled and un-soiled parts

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Benchmarking Study

Latex Features

Reference of latex	Origin	Chemical nature of the binder	T_g (ºC) (Technical Data Sheet)	T_g (°C) (Measured – Onset)
# 1	Competition	Acylic	-25	**-19.6**
# 2	Competition	Acrylic	-28	**-21.7**
# 3	Competition	Acrylic	-28	**-25.4**
# 4	Internal	Acrylic	-25	**-18.7**
# 5	Internal	Acrylic	-24	**-20.1**
Latex B	*Internal*	*Pure Acrylic – LEB*	*-22*	***-20.2***

Binders with similar T_g levels were selected among market references

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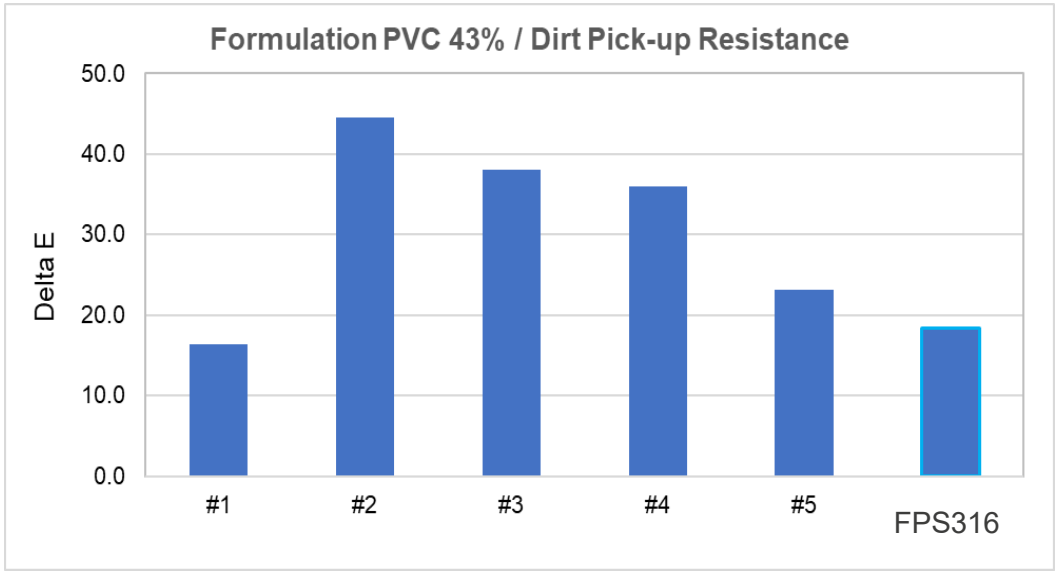
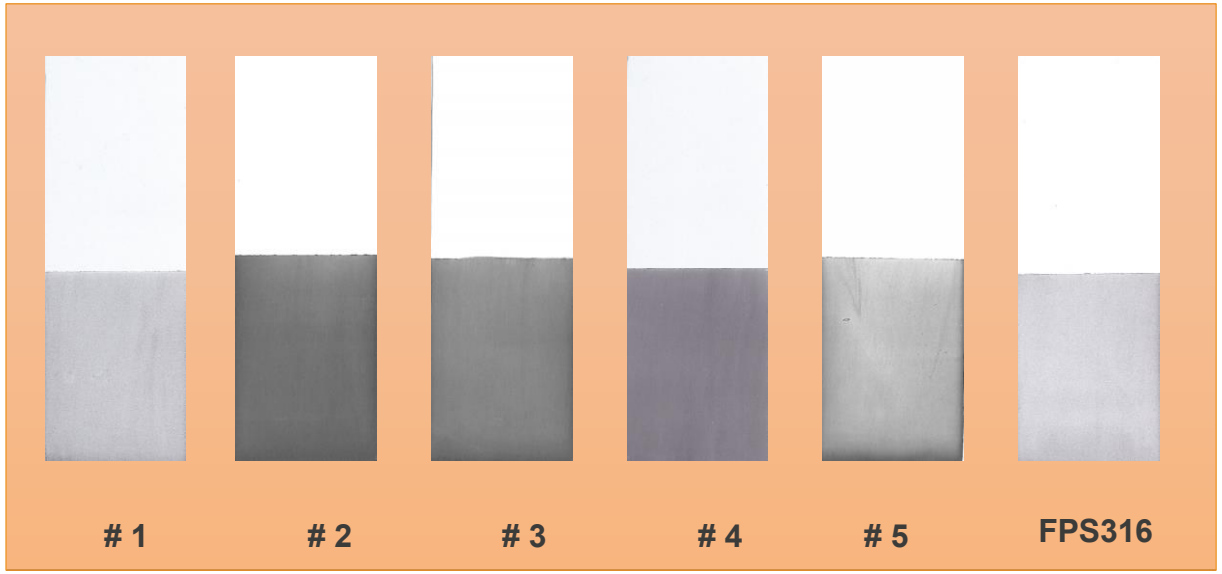
Results





Paint FPS316 based on Latex B exhibits very good dirt pick-up resistance

The Dirt Pick-Up Resistance Battle

FPS 316 - Experimental formulation for Elastomeric Wall Coating

Raw Materials		%
	Water	11.15
Latex B		**30.00**
Cellulosic thickener		0.15
Buffer		0.20
Dispersing agent		0.50
Defoamer		0.30
Titanium dioxide		11.30
Calcium carbonate 1		7.50
Calcium carbonate 2		15.0
Talc		6.60
Latex B		**9.60**
	Water	3.30
Coalescing solvent		3.00
Defoamer		0.20
Associative thickener 1		0.50
Associative thickener 2		0.20
Paint film preservative		0.50

Weight Solid (%)	61.6
Volume Solid (%)	46.3
PVC (%)	42.7
PVC / CPVC	0.70
Specific Gravity	1.41
MFFT (°C)	0°C

Matte vs. Semi-Gloss

Dirt Pick-Up Resistance Testing per SYN Method

- Purpose: To evaluate the ability of the surface of horizontal coatings to repel the build up of dirt on the surface that may cause a change in appearance and/or color of the coating
- The coating is drawn down at 20-mils wet using a Bird bar on a Leneta Chart
- The coatings were allowed to dry for 7 days prior to testing at room temperature
- Color readings were taken of the coated surface using a Delta Tools Spectrometer and the L, a, and b values were recorded
- A layer of dry black iron oxide pigment is applied in a thin layer on the coating and allowed to sit on the surface for 1 hour
- At the end of the hour, the chart is placed under a stream of water from the faucet to wash the pigment off of the surface. The chart is then left to dry for 24 hours
- Once dried, color readings are again taken at the spot where the pigment was left to sit. Delta E (ΔE) is then calculated using the original and post pigment/dirt exposure to describe the color change. Photos were also taken.

Dirt Pick-Up Resistance – Matte Finish

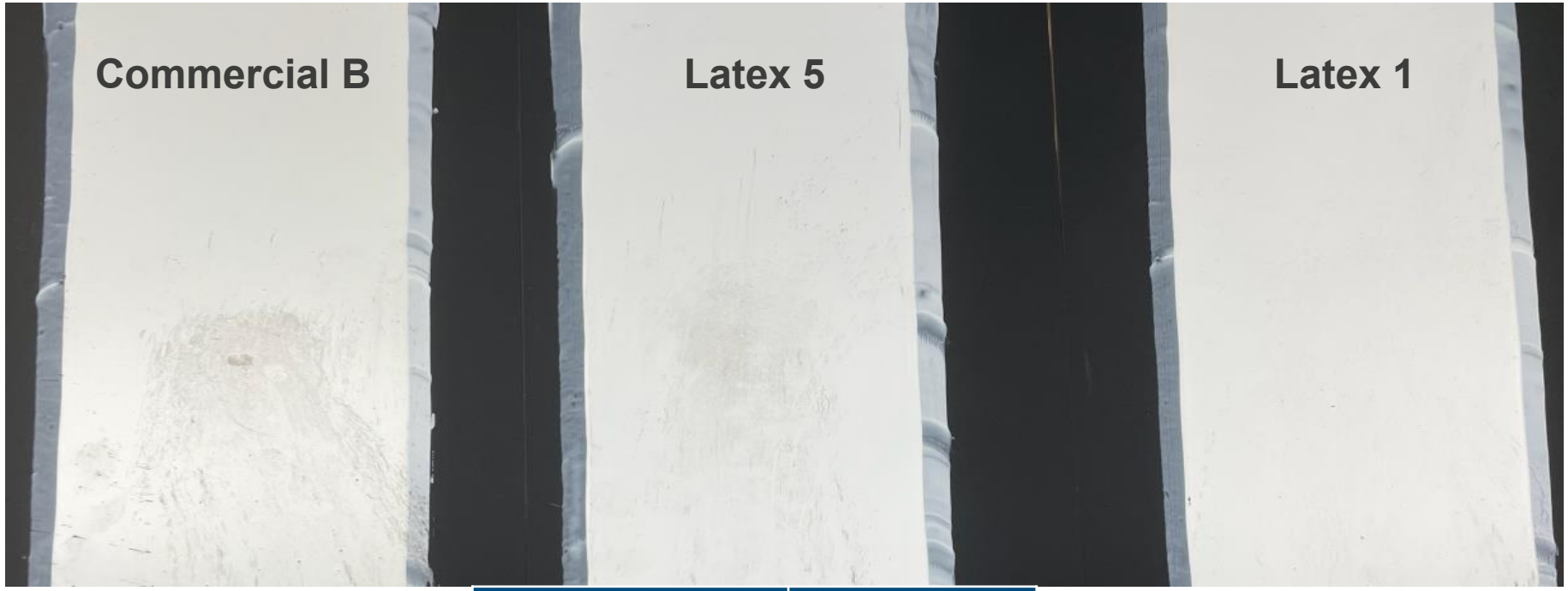
Product	Δ E
Commercial B	16.7
Latex 5	19.9
Latex 1	8.1

Washability after DPUR per SYN Method

- Purpose: To evaluate the ability of the surface of horizontal coatings to repel the build up of dirt on the surface that may cause a change in appearance and/or color of the coating
- A wet sponge is used to attempt to clean off any loose residue from the surface of the panel after the final reading is taken
- The sponge is applied with light pressure to the surface to wipe away any “dirt” that can be easily removed
- The panel is then left to dry for 24 hours
- Once dried, the color readings are again taken, and a Delta E (ΔE) is calculated based on the initial values of the clean coating before the test was begun

The Dirt Pick-Up Resistance Battle

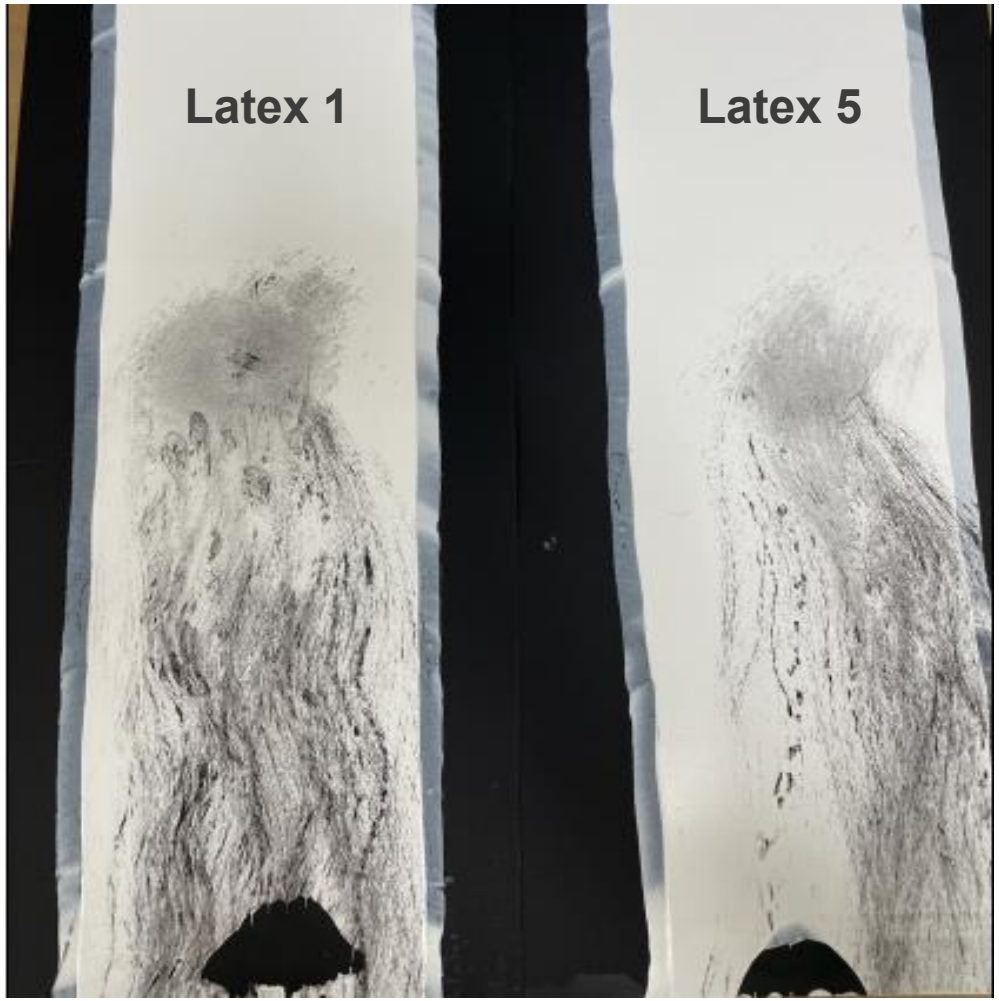
Washability After DPUR Testing – Matte Finish



Product	Δ E
Commercial B	6.9
Latex 5	4.6
Latex 1	1.1

Dirt Pick-Up Resistance – Semi-Gloss Finish

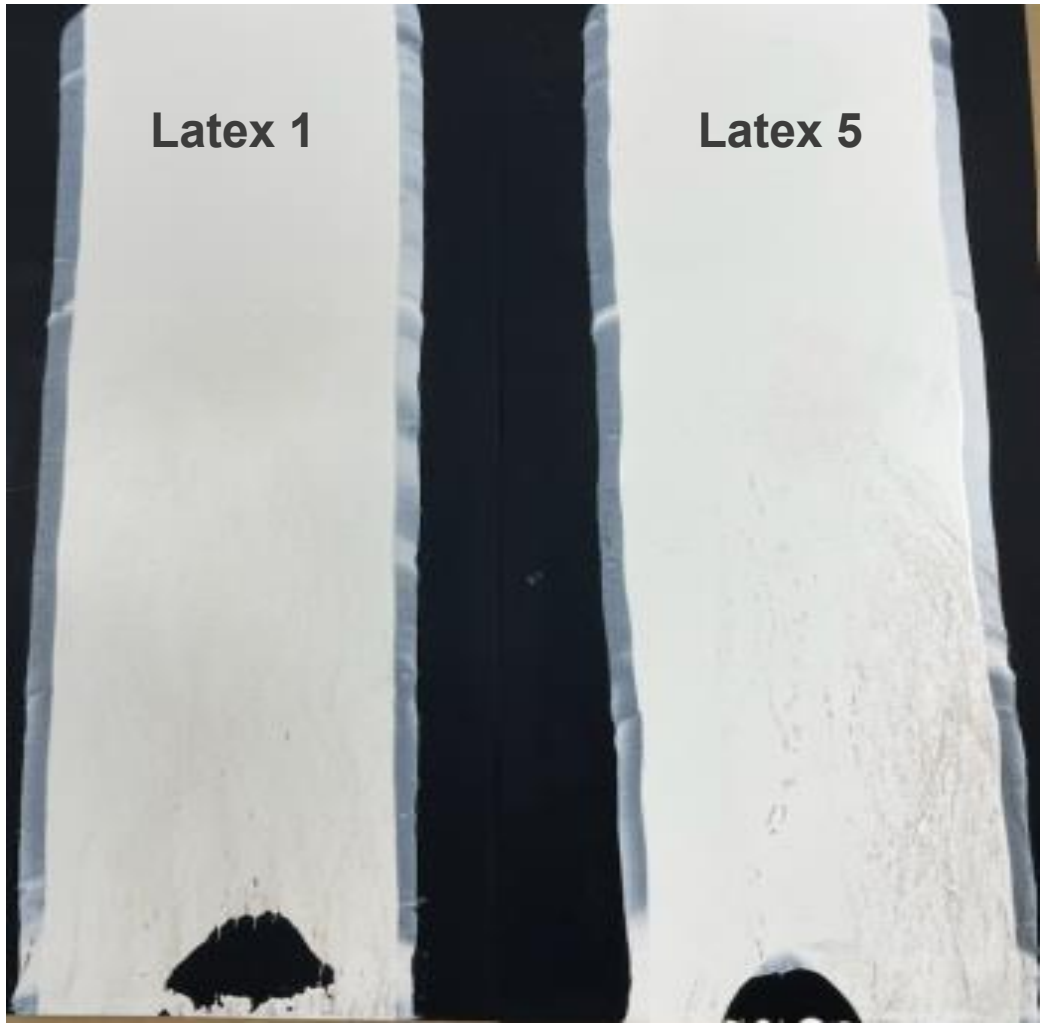
Product	∆ E
Latex 1	18.9
Latex 5	14.3



The Dirt Pick-Up Resistance Battle

Washability After DPUR Testing – Semi-Gloss Finish

Product	∆ E
Latex 1	2.7
Latex 5	1.5



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Matte vs. Semi-Gloss Finish

Test	Finish	Latex in Coating	Δ E
DPUR	Matte	Latex 1	8.1
DPUR	Semi-Gloss	Latex 1	18.9
DPUR	Matte	Latex 5	19.9
DPUR	Semi-Gloss	Latex 5	14.3

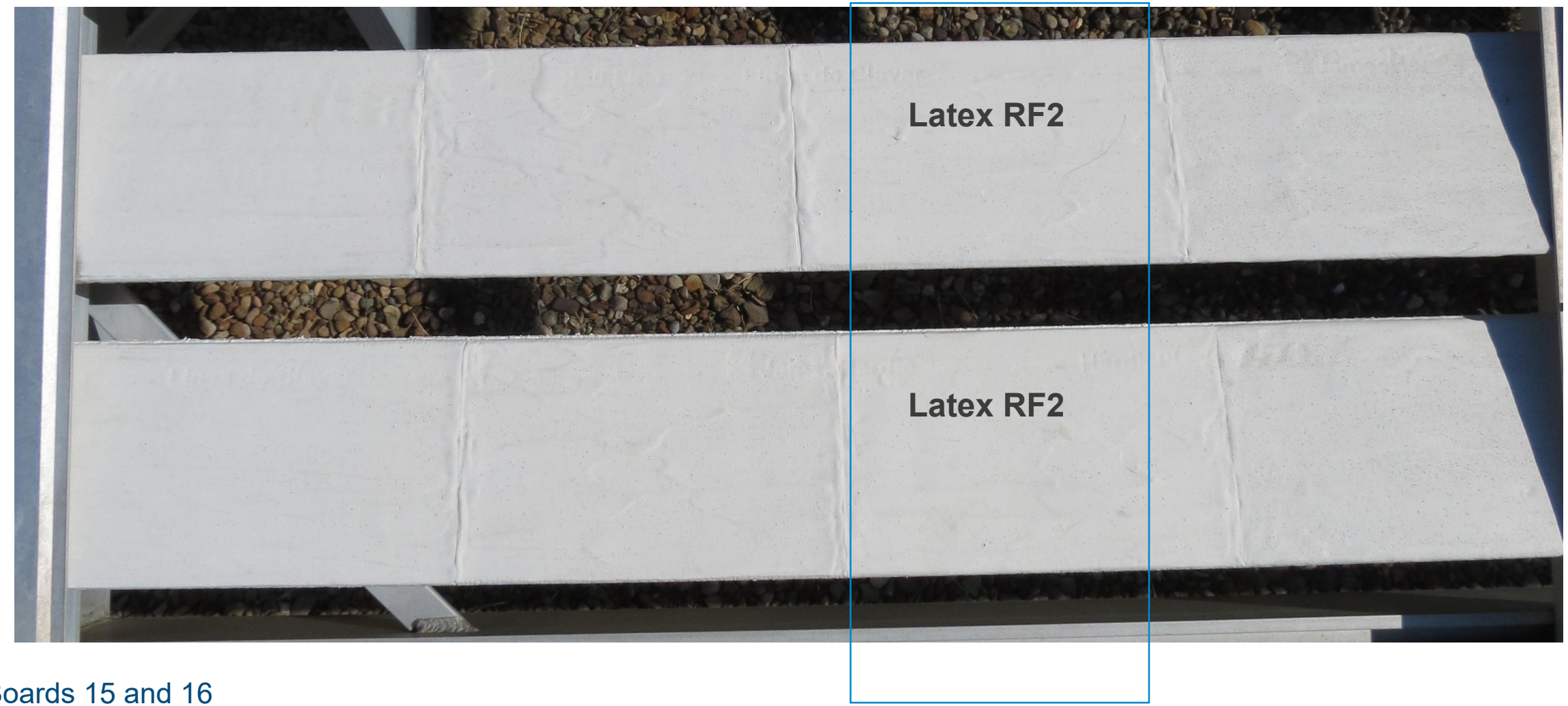
Test	Finish	Latex in Coating	Δ E
Washability	Matte	Latex 1	1.1
Washability	Semi-Gloss	Latex 1	2.7
Washability	Matte	Latex 5	4.6
Washability	Semi-Gloss	Latex 5	1.5

Test Methods

2. Exterior Exposure

The Dirt Pick-Up Resistance Battle

Roof Coatings; 24 Months Exposure, Horizontal, in Duplicate



Boards 15 and 16

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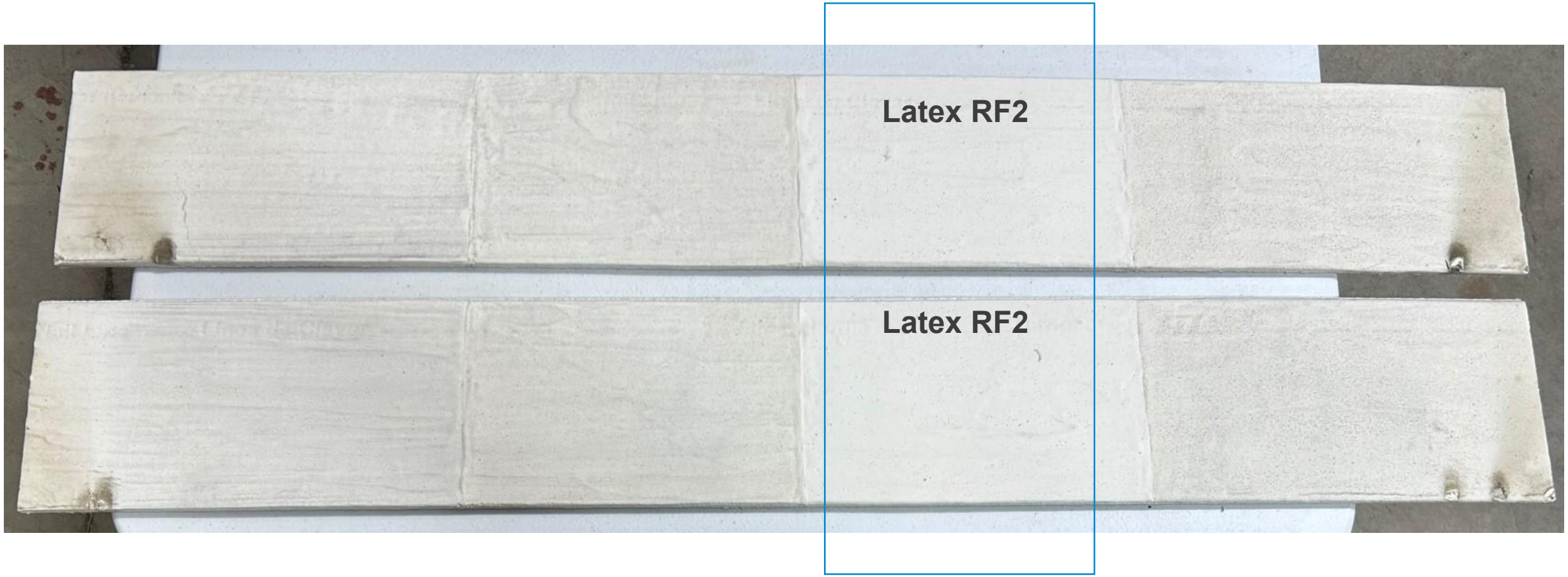
Roof Coatings; 48 Months Exposure, Horizontal, in Duplicate



Boards 15 and 16

The Dirt Pick-Up Resistance Battle

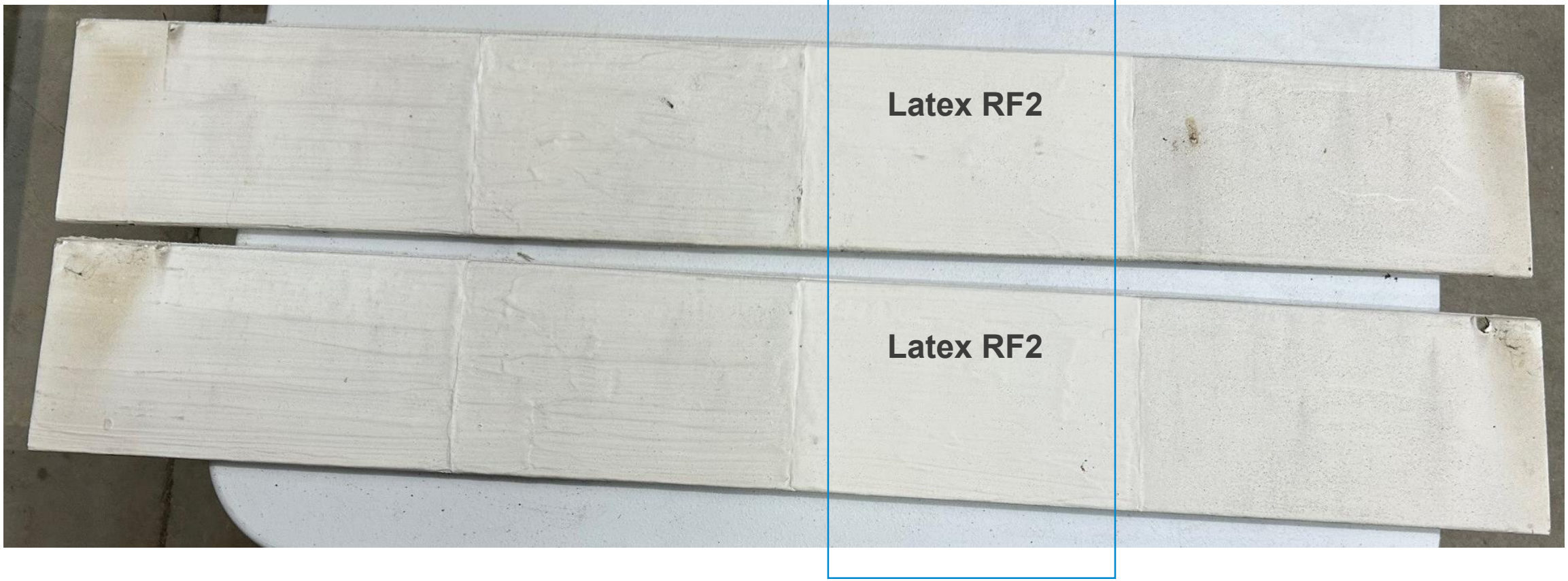
Roof Coatings; 24 Months Exposure, Vertical, in Duplicate

Boards 17 and 18

The Dirt Pick-Up Resistance Battle

Roof Coatings; 48 Months Exposure, Vertical, in Duplicate

Boards 17 and 18 were vertical



Comparison Data - Coatings Based on RF2 Latex

Exposure Time	Position	Δ E
2 years	Horizontal	6.2
2 years	Vertical	5.8
4 years	Horizontal	5.3
4 years	Vertical	5.1

Summary

- There are several different methods used for determining dirt pick-up resistance.
- The self cross-linking latexes exhibit better dirt pick-up resistance in this accelerated testing study.
- Semi-gloss coatings typically have better dirt pick-up resistance, but as seen in this report, that is not always the case.
- It is very important to always include a control, and test multiple coatings at the same time.
- Latex 2 exhibited excellent dirt pick-up resistance in accelerated testing.
- Latex RF2 had excellent dirt pick-up resistance after 4 years of exterior exposure. The position of the panels did not affect the ΔE.

References

1,2 Towards a Comprehensive Understanding of Dirt Pickup Resistance: Architectural Coatings — https://www.paint.org/coatingstech-magazine/topics/technologies/architecturalcoatings/

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