SNAME MARITIME 2022 CONVENTION

26-29 September | Houston, TX

# Evaluating Surface Preparation for Maintenance Recoating: Testing Waterjetting, Salts, Inhibitors

**Presented by: Alex Petkas, PhD., HoldTight Solutions, Inc.**

HOLDTIGHT

# Testing Goals

- Assess methods for maintenance recoating in offshore environments
- Assess long-term (5 year) performance of UHP, Dry Grit Blasting
- Assess impact of Decontamination Chemical (DC) (or “inhibitor”) used in surface preparation
- Provide basis for evaluating ISO 12944-9 standard

# Preparing the Panels (2015)

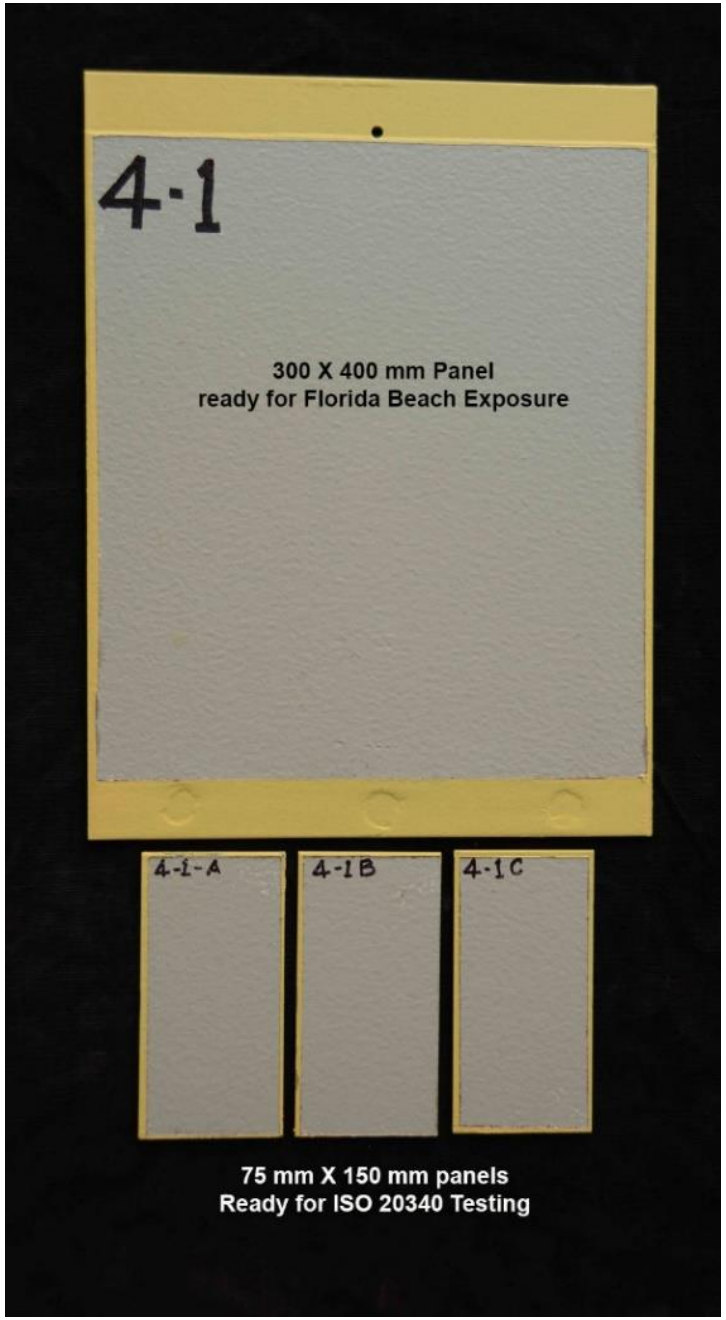
- 6 panels
- Panels all first Dry blasted to NACE 1/SSPC SP5 (white metal blast)
- 3.1-3.9 mil profile (garnet)
- Panels subjected to 2 week pre-rusting procedure in order to simulate offshore coating failure situation typical in maintenance recoating
- Panels then re-prepared according to table in following slide
- (Procedure is detailed in 2017 NACE paper)

# Panel preparation table

| Sample # | Surface Preparation | Coating |
|---|---|---|
| 1-1 | 38,000psi Waterjet + decontamination chemical (DC) | Glass flake Epoxy |
| 2-1* | 38,000psi Waterjet | Glass flake Epoxy |
| 3-1 | 38,000psi Waterjet + DC + Seawater Mist | Glass flake Epoxy |
| 4-1 | Dry Garnet Blast + Power wash w/ DC | Glass flake Epoxy |
| 5-1* | Dry Garnet Blast + Power wash | Glass flake Epoxy |
| 6-1 | Dry Garnet Blast + Power wash, DC , + Seawater Mist | Glass flake Epoxy |

# Decontamination Chemical

- **Decontamination chemical was used in a LP pressure wash (approximately 3000 PSI) after initial UHP / Dry blasting on panels 1-1, 3-1, 4-1, 6-1**
- **Decontamination Chemical is a relatively established industry product used to control flash rust (rust bloom) and remove excess soluble salts.**
- **Decontamination chemical diluted 50:1 to yield a 2% solution in LP pressure wash water**




# Prepared panel

- Each of the original 6 panels cut down according to the diagram
- Large piece submitted to 5-year exposure
- 3 smaller pieces submitted to shorter term ISO-20340 Testing
  - (ISO-20340 = updated as ISO-12944-9)
- This presentation details testing procedure performed on Large piece

# Exposing the panels

- ASTM G50 used for long term field exposure test
- Racks are 150 ft from high tide line

NASA BEACHSIDE CORROSION TESTING FACILITY

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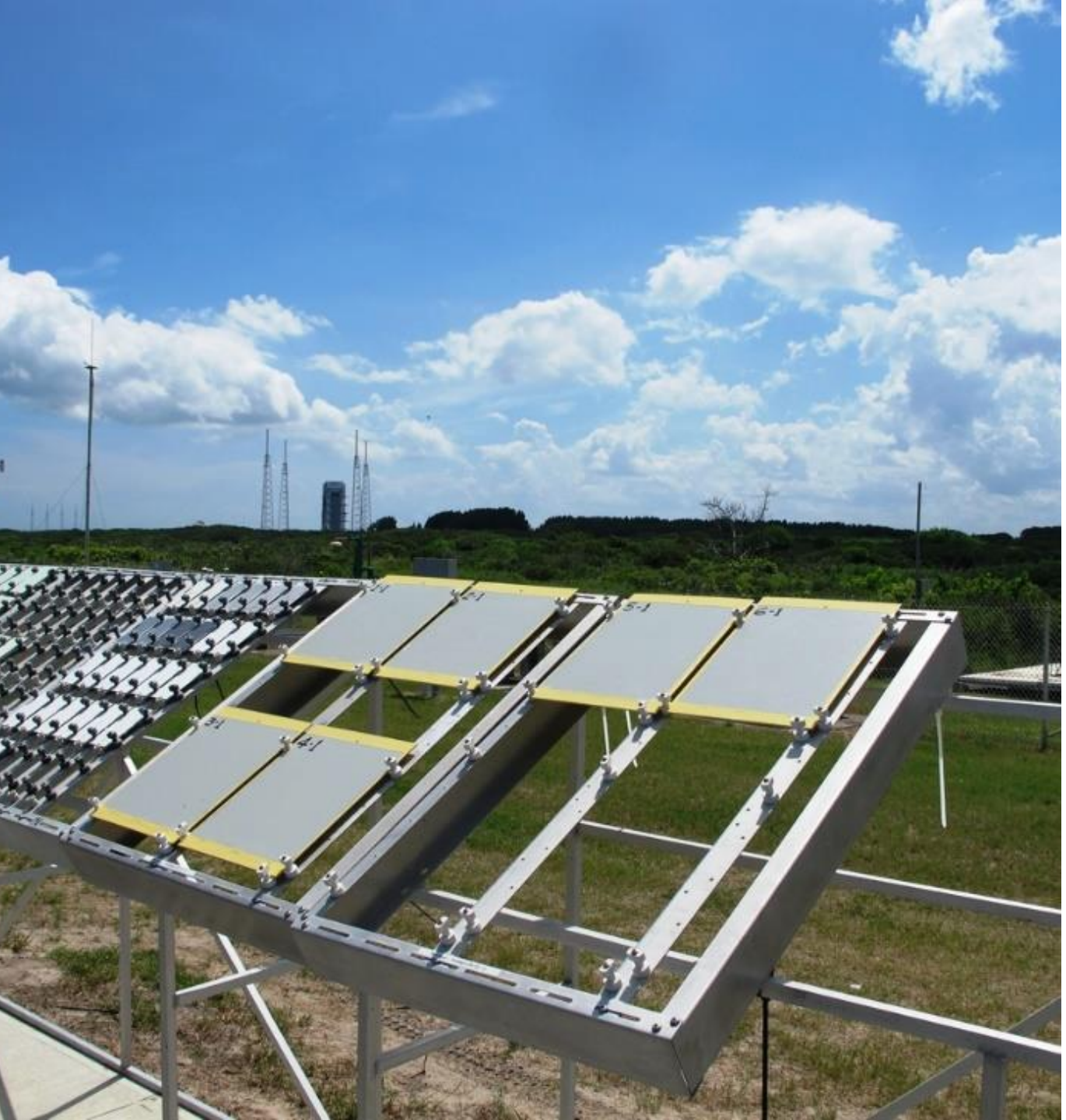


# Exposing the panels for 5 years

- Rack designed according to ASTM G50
- Scribe test performed at regular intervals (ASTM D1654)
- Adhesion Pull test performed at regular intervals (ASTM D4541)

PANELS DEPICTED AS INSTALLED AT

NASA BEACHSIDE CORROSION TESTING FACILITY

# Scribe Test Detail

- Scribe test readings were taken in 2018-2021 in February.
- Readings were taken 12 months after each scribe was performed
- In order to make the initial scribe, panels were removed from rack and cleaned with solvent, then scribed with 1/16” carbide tipped ball mill
- Panels were then reinstalled to continue long term test

# Scribe Results

## RESULTS

| Scribe Ratings | | | | | |
|---|---|---|---|---|---|
| **Panel ID** | 2018 | 2019 | 2020 | 2021 | Decontamination Chemical (DC) |
| **1-1** | 6 | 10 | 10 | 10 | DC Used |
| **2-1** | 5 | 10 | 10 | 10 | Without DC |
| **3-1** | 6 | 10 | 10 | 10 | DC Used |
| **4-1** | 10 | 10 | 10 | 10 | DC Used |
| **5-1** | 10 | 10 | 10 | 10 | Without DC |
| **6-1** | 10 | 10 | 10 | 10 | DC Used |

## (KEY)

| Representative Mean Creepage from Scribe | | |
|---|---|---|
| **Millimeters** | Inches (Approximate) | Rating |
| **Zero** | 0 | 10 |
| **Over 0 to 0.5** | 0 to 1/64 | 9 |
| **Over 0.5 to 1.0** | 1/64 to 1/32 | 8 |
| **Over 1.0 to 2.0** | 1/32 to 1/16 | 7 |
| **Over 2.0 to 3.0** | 1/16 to 1/8 | 6 |
| **Over 3.0 to 5.0** | 1/8 to 3/16 | 5 |
| **Over 5.0 to 7.0** | 3/16 to 1/4 | 4 |
| **Over 7.0 to 10.0** | 1/4 to 3/8 | 3 |
| **Over 10.0 to 13.0** | 3/8 to 1/2 | 2 |
| **Over 13.0 to 16.0** | 1/2 to 5/8 | 1 |
| **Over 16.0 to more** | 5/8 to more | 0 |

# Scribe Test Sample Close-up


| Panel ID | 2018 |
|---|---|
| 1-1 | 6 |
| 2-1 | 5 |
| 3-1 | 6 |
| 4-1 | 10 |
| 5-1 | 10 |
| 6-1 | 10 |

- **2018 scribe depicted here at time of testing**
- **(1 year after initial scribe made)**

# Adhesion Pull-off Test Detail

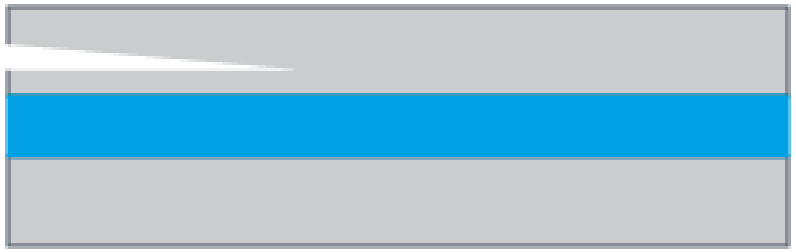
- Four Adhesion pull-off tests made per panel in successive years (2018-2021)
- Locations selected at least 3 inches from any scribe test site
- All failures were deemed cohesive
- Some failures 100% cohesive
- Others 95% cohesive, 5% adhesive
  - This is Within tolerance of the test
- Variation from year to year was within the tolerance of the test (not statistically significant)

# Adhesive vs. Cohesive Failure

- All failures were deemed Cohesive, i.e.:
- Failure point was internal tensile strength of coating rather than strength of adhesion to substrate

Adhesive failure

Cohesive failure



Substrate failure

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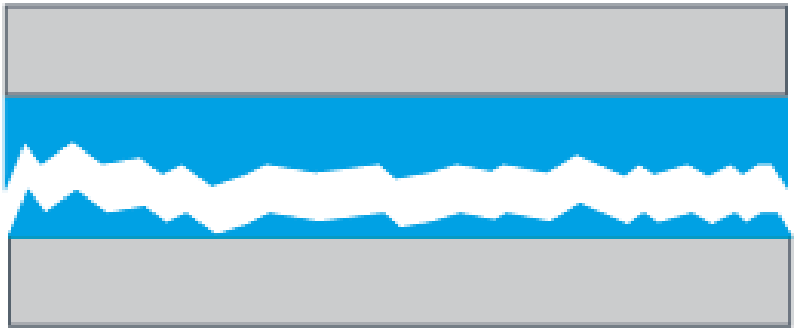
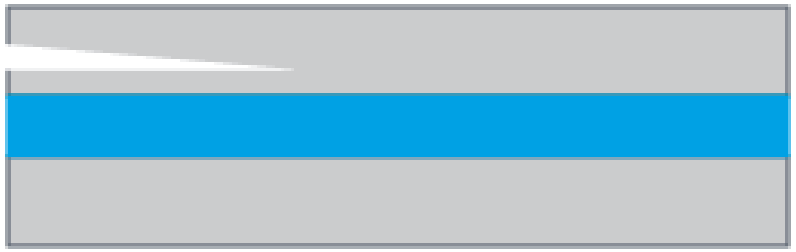


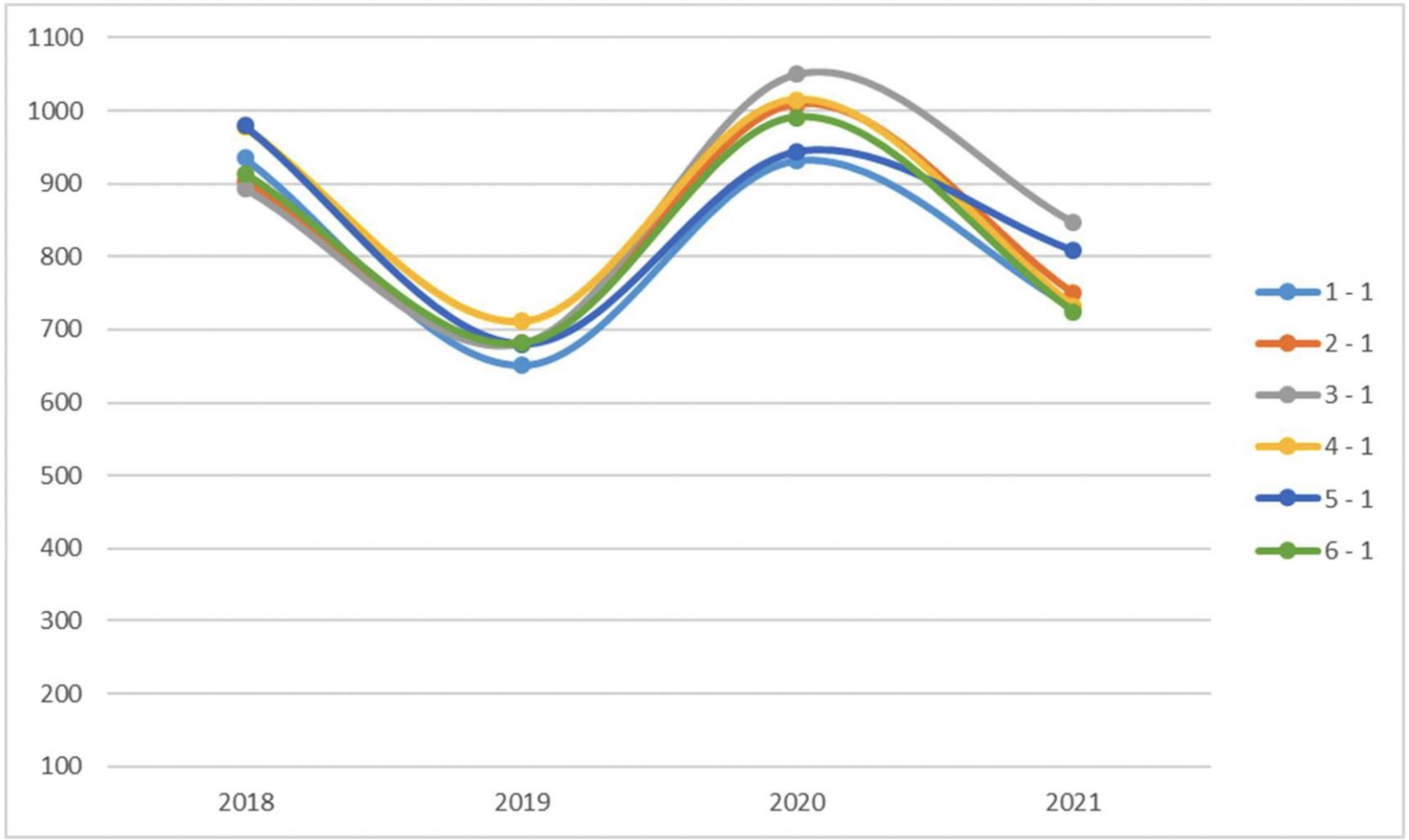
Cohesive failure



Substrate failure

# SUMMARY GRAPH OF ADHESION TEST RESULTS

**PULL OFF TEST STRENGTH (IN PSI)**




YEAR

# SAMPLE TABLE OF ANNUAL ADHESION RESULTS

- **Results from 2019 shown**
- **Full results available upon request or in published article**

**Table 5.**
**2019 Adhesion Data**

| Panel | POTS (psi) | POTS (kPa) | Failure Mode | Average POTS (psi) | Average POTS (kPa) | Percent Difference |
|---|---|---|---|---|---|---|
| 1 - 1 | 649 | 4476 | 95% Cohesive/5% Adhesion Failure | 651 | 4487 | 9 |
| | 647 | 4462 | | | | |
| | 684 | 4719 | | | | |
| | 622 | 4291 | | | | |
| 2 - 1 | 666 | 4590 | 100% Cohesive Failure | 681 | 4697 | 12 |
| | 651 | 4491 | | | | |
| | 676 | 4662 | | | | |
| | 732 | 5046 | | | | |
| 3 - 1 | 713 | 4918 | 100% Cohesive Failure | 681 | 4697 | 8 |
| | 658 | 4533 | | | | |
| | 678 | 4676 | | | | |
| | 676 | 4662 | | | | |
| 4 - 1 | 682 | 4704 | 100% Cohesive Failure | 711 | 4900 | 6 |
| | 715 | 4932 | | | | |
| | 719 | 4961 | | | | |
| | 726 | 5003 | | | | |
| 5 - 1 | 715 | 4932 | 95% Cohesive/5% Adhesion Failure | 680 | 4690 | 14 |
| | 643 | 4434 | | | | |
| | 728 | 5018 | | | | |
| | 635 | 4377 | | | | |
| 6 - 1 | 618 | 4263 | 95% Cohesive/5% Adhesion Failure | 682 | 4701 | 15 |
| | 691 | 4761 | | | | |
| | 717 | 4946 | | | | |
| | 701 | 4832 | | | | |

# Some Conclusions

- **Adhesion tests did not show any statistically significant pattern among the various surface preparation methods. All failures were deemed cohesive.**

- **The panels subjected to UHP surface preparation method exhibited more corrosion undercreep on the scribe test. UHP panel treated with DC (decontamination chemical) suggested increased resistance to undercreep.**

- **The results of this ASTM G 50[4] 5-year long-term test should be compared with the short-term ISO 20340[1] testing. (ISO 20340[1] has been updated with ISO 12944-9[7])**

# Acknowledgements

**We wish to express our thanks to Jerome Curran of NASA BCTS, who oversaw the 5-year field test, as well as to Halina Wisniewski for her oversight of the initial panel preparation procedure and the performance testing per ISO 2034**

**Thank you for your attention this concludes the presentation**

**Questions?**

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