SERDP/ESTCP Workshop
Surface Finishing & Repair Issues for Sustaining New Military Aircraft

Fiesta Resort & Conference Center, Tempe, AZ
Feb 26-28,2008

Pre-Coated Fasteners

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Report Documentation Page

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a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**34**	

Project Overview

- **Problem**
  - **Military standards require permanently installed fasteners to be treated with a corrosion-inhibiting, "wet" sealant prior to installation to meet the stringent corrosion performance required by the military aerospace operational environment.**
  - **The process is expensive, time consuming, subject to technician error, and requires the use of an environmentally hazardous sealant.**
  - **Removal and replacement of "wet installed" fasteners by field and depot technicians is labor intensive, leading to increased down time for aircraft repairs.**

- **Objectives**
  - **Dem/Val laboratory and field performance of a candidate pre-coated/self-sealing fastener technology on Navy/USMC aircraft in operating environments and compare to existing practices**
  - ***Deliver a qualified precoated aluminum fastener for fleet use***

Why Wet Install?

- **Prevent crevice corrosion around fastener head that leads to filiform corrosion**

- **History-**
  - **Wet installation of fasteners with a type of chromated sealant goes back to the first metal Navy Aircraft and before…..for almost 100 years.**
  - **Why? *<u>Because it worked</u>* in mitigating corrosion.**

Project Overview

Impact to Fleet/Issues

- Equivalent to and/or improved corrosion protection from a “dry” ready-to-use fastener
- Elimination of hazardous solvents and reduction in hazardous waste
- Reduce maintenance and corrosion repair cost
- Simplifies installation (eliminate wet installation), reducing installation time and cost
- Eliminates human element of current sealant process resulting in uniform watertight seals reducing airframe corrosion
- Increase aircraft/vehicle readiness level

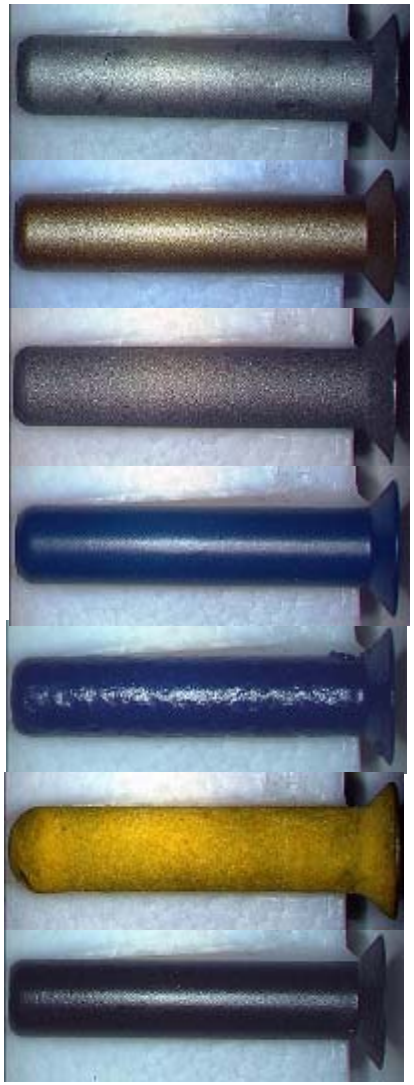
Evaluation Factors

- **Performance**
  - Corrosion protection
  - Visual difference
  - Neutral environmental impact
- **Cost**
  - Low impact
- **Production/manufacture**
  - High volume manufacturing
- **Logistics**
  - Shelf life

Project Overview

Initial Candidate Coated Fasteners

Surface Coatings



Magnesium Rich Primer - dry

Hi-Cote (phenolic based aluminum coating)

Magni 565 (Zn-rich basecoat w/Al-rich topcoat)

FluorKote1 (fluoropolymer coating)

Xylan 1424 (waterborne, dry-film lube with PTFE)

ND Microspheres (microcapsules of epoxy resin)

Xylan 1020 (similar to Xylan 1424)

Gasket

NySeal (pre-applied uncured sealant)

Control #1

no coating Cr Conversion only

Control #2

Plain FastenerWet Sealed/polysulfide sealant

SBIR PH II

SMRC-Quickseal/pre-applied non-cured sealant

METSS

Hybrid w/ (Nyseal) Gasket

Magni 565 & Nyseal

Hi-Cote & Nyseal

Xylan 1424 w/ Nyseal

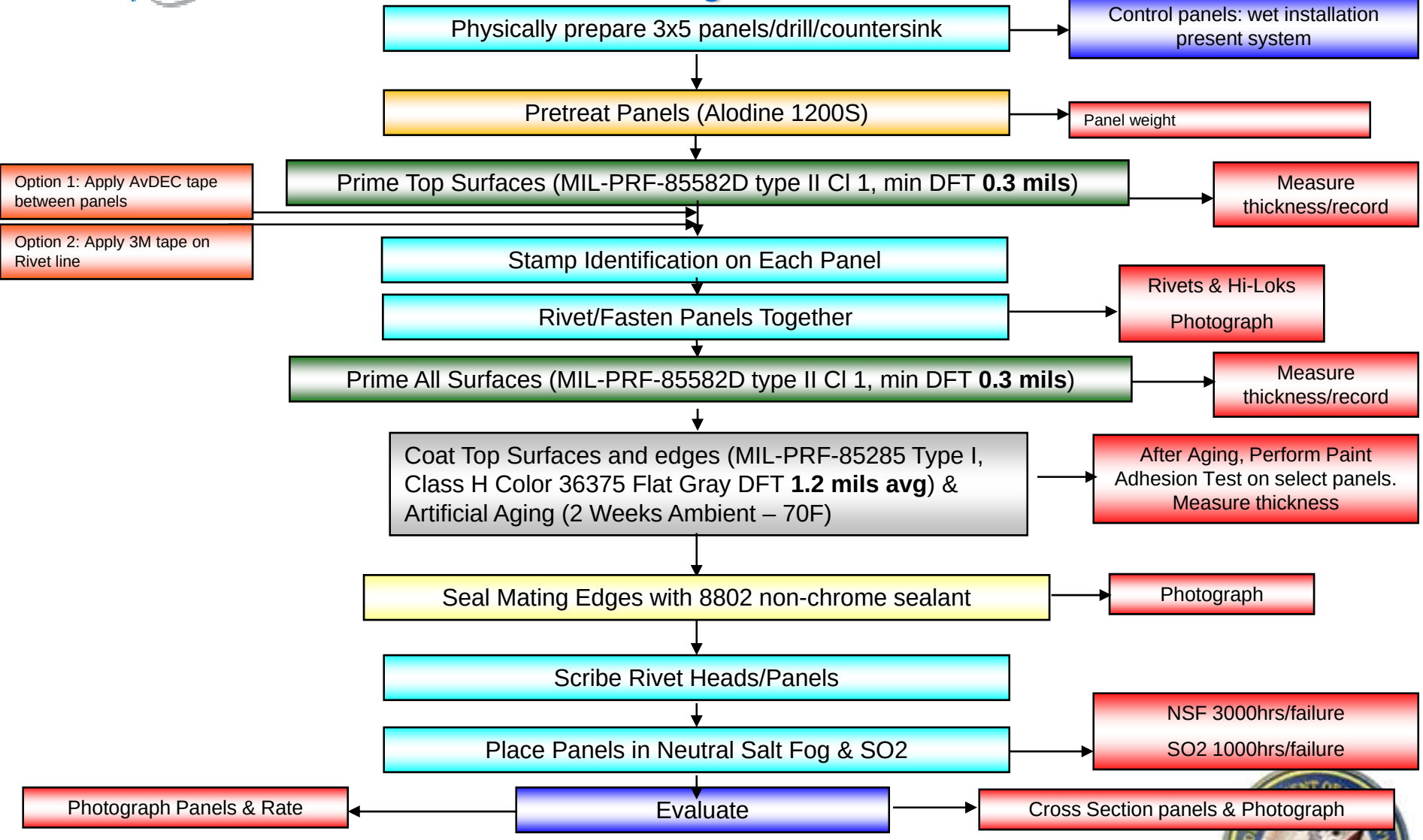
Test Panel & Fastener Matrix – Riveted Panels

	ID	Test Method	Comments	Panel Sets			
	A	**Salt Fog Atmosphere Per ASTM B117**	**Phase I Down Selection**	**51**			
	B	**Salt/SO2 Fog Atmosphere Per ASTM G85-A4**	**Phase I Down Selection**	**51**			
	C	**Beach Exposure Testing**	**Long Term Observation to Correlate to Salt & S02**	**17**			
	ID	Coating/Installation Method	Comments	NSF	SO2	Beach	Total Panels
1	A	**Wet install – current method**	**Baseline**	**3**	**3**	**1**	**7**
2	B	**Primer Mag Rich - Dry**	**Dry installed**	**3**	**3**	**1**	**7**
3	C	**Hi-Kote 1**	**Phenolic based aluminum coating**	**3**	**3**	**1**	**7**
4	D	**FluorKote1 (blue)**	**Fluoropolymer coating**	**3**	**3**	**1**	**7**
5	E	**Xylan 1070 (black)**	**similar to 1424**	**3**	**3**	**1**	**7**
6	F	**Xylan 1424 (blue)**	**Waterborne, dry-film lube with PTFE**	**3**	**3**	**1**	**7**
7	G	**Magni 565**	**Zn-rich basecoat w/Al-rich topcoat**	**3**	**3**	**1**	**7**
8	H	**ND Microspheres (yellow)**	**Unknown - waiting recommendation**	**3**	**3**	**1**	**7**
9	K	**NySeal (green)**	**Preapplied sealant**	**3**	**3**	**1**	**7**
10	J	**NySeal & Magni 565**	**Hybrid**	**3**	**3**	**1**	**7**
11	I	**NySeal & Hi-Kote**	**Hybrid**	**3**	**3**	**1**	**7**
12	L	**NySeal & Xylan 1424**	**Hybrid**	**3**	**3**	**1**	**7**
13	M	**SMRC Product (gray)**	**Preapplied sealant 2001**	**3**	**3**	**1**	**7**
14	N	**METSS Product (brown)**	**Preapplied sealant**	**3**	**3**	**1**	**7**
15	O	**Contro, Plain Rivets**		**3**	**3**	**1**	**7**
16	P	**Plastisol**		**3**	**3**	**1**	**7**
17	Q	**AvDEC tape seal**	**Sandwich the AvDEC tape**	**3**	**3**	**1**	**7**
			Totals	51	51	17	119

Testing Summary

- **Phase I: Initial Screening testing**
  - **Corrosion only**
  - **Various coatings, tapes, surface treatments for dry installation**
    - Evaluate using Aluminum Countersunk Rivets
  - **Current chromated primer/pretreatment used for evaluaton**
- ***Downselect***
- **Phase II: Final Screening testing**
  - **Retest using non-chrome pretreatment and non-primer panel setup**
    - Nonchrome fastener
  - **Fluids compatibility**
  - **Physical/mechanical testing**
  - **Leak Testing**
  - **On-Aircraft testing**
- **Phase II A:**
  - **Start steel, Hi-lok^{tm} & titanium fasteners**

Phase I Screening Test Flowchart

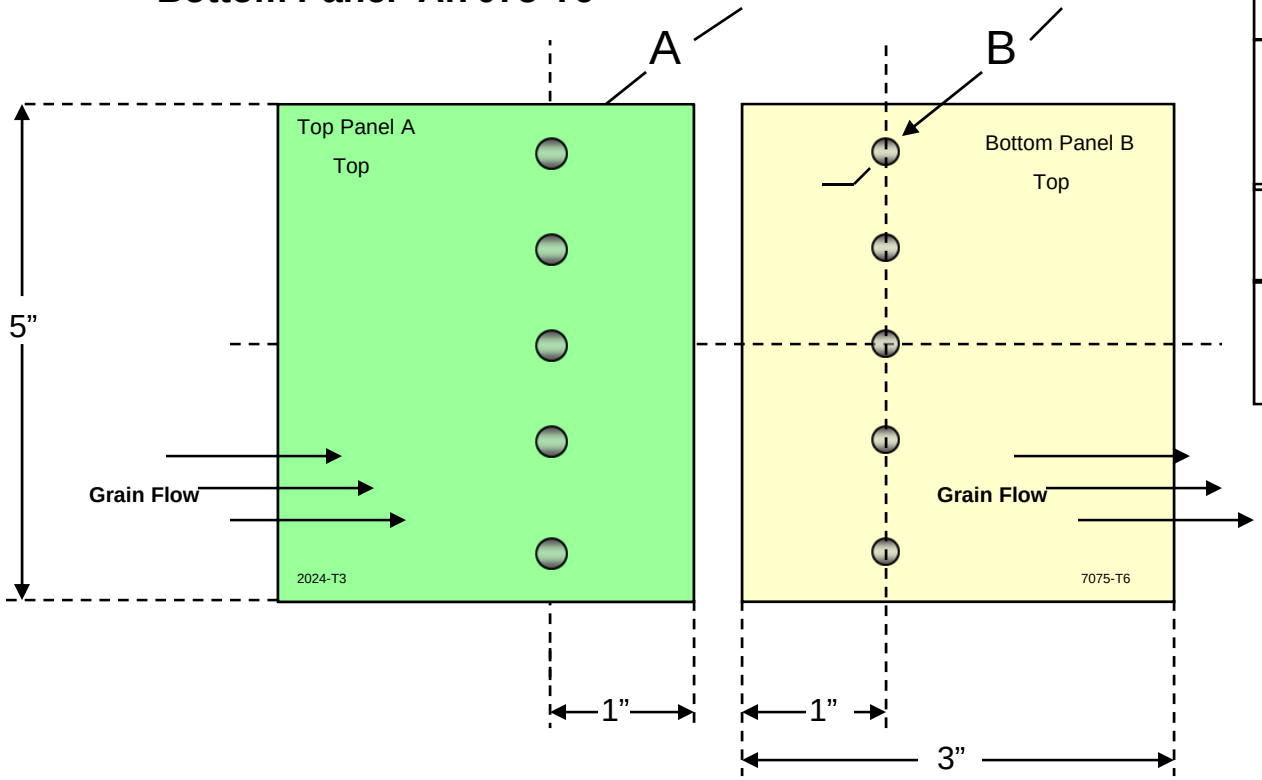


Test Panel Preparation/Pretreatment

Fasteners – Al 2117-T4 (chromated)

Top Panel- Al 2024-T3

Bottom Panel- Al7075-T6



Note A: Top Panel 2024-T3, Dimensions 3in wide x 5in length x 0.25in thick, Countersink 0.25 in 5 Places, starting center at 0.5 inches from short side edge – 1 inch in from long side edge, then drill 1 inch apart on center. Drill through after counter sink 0.1875 inch diameter.

Note B: Bottom Panel 7075-T6, Dimensions 3in wide x 5in length x 0.25in thick, 5 Places, starting center at 0.5 inches from short side edge – 1 inch in from long side edge, then drill 1 inch apart on center, drill through each 0.1875 inch diameter.

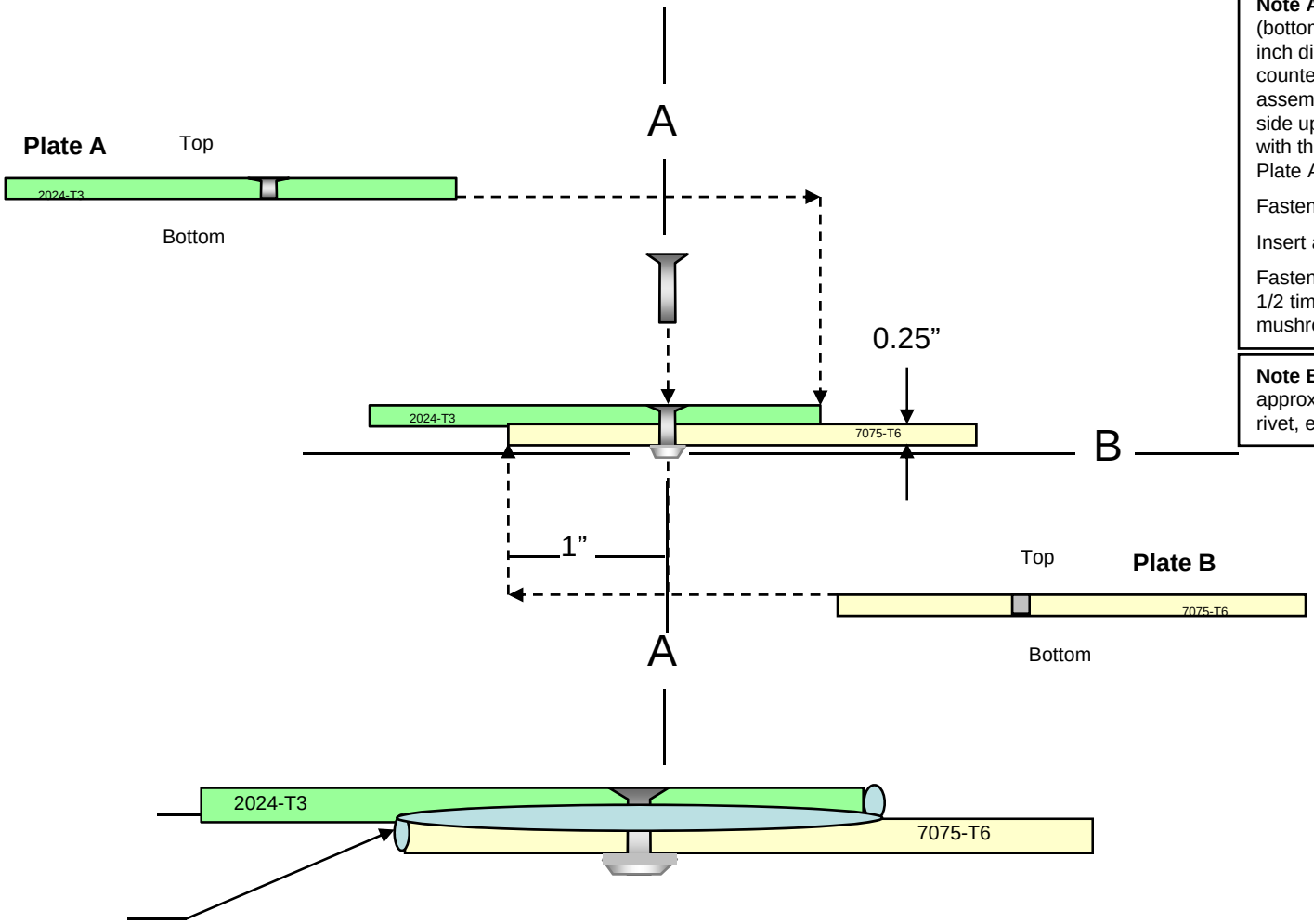
Note C Pretreatment: Pretreat all surfaces IAW MIL-DTL-5541, Type I, Class 1A (Alodine^{tm} 1200s). 40-70mg/sqft

Note D: 1st Prime coat, all top surfaces as shown and edges one (1) coat each to each panel of average thickness of 0.3 mils of MIL-PRF-85582 Type II, Class C1. Measure thickness after priming & record.

Material: Top Plate Al 2024-T3 3inx5inx0.25in thick, Bottom Plate Al 7075-T6 3inx5inx0.25in thick.

Grain direction parallel to short dimension

Dry Install Test Panel: Riveted Assembly



Note A: Assemble Plate A (top) to Plate B (bottom) flush, using MS20426AD5-12 3/16 inch diameter fasteners. Top Plate A, countersink/coated side facing up when assembling. Bottom plate B orientation – coated side up. Coated top of bottom plate B will mate with the uncoated (not painted) bottom side of Plate A.

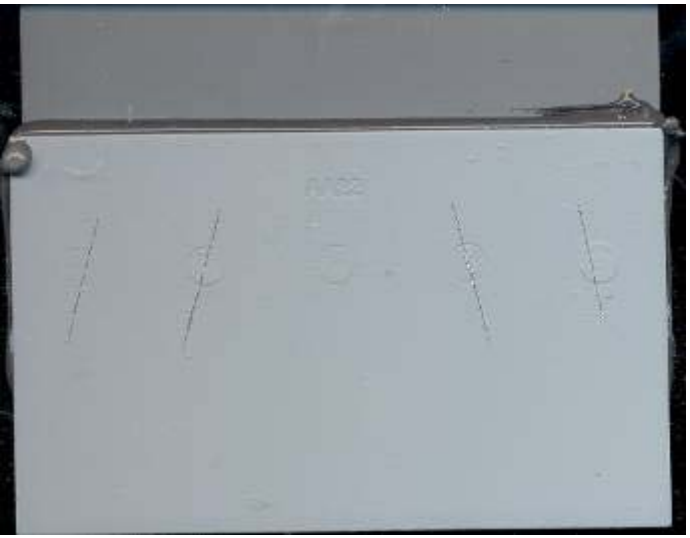
Fasten per PS19000

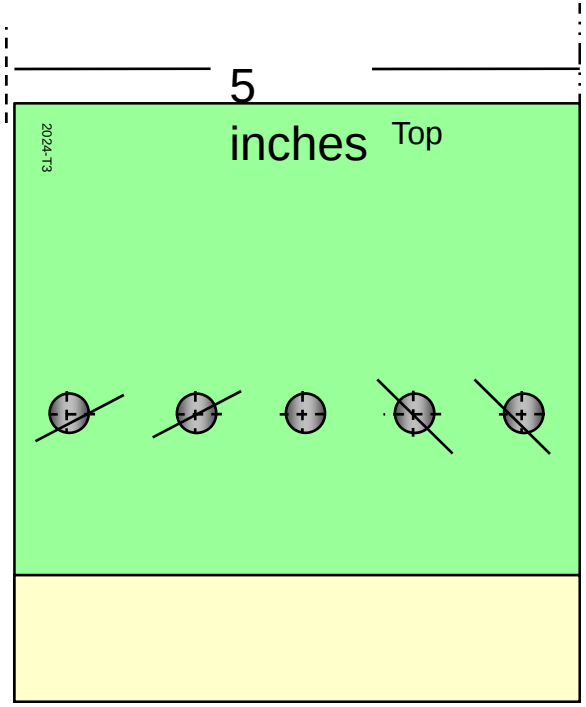
Insert and fasten using rivet gun & bucking bar

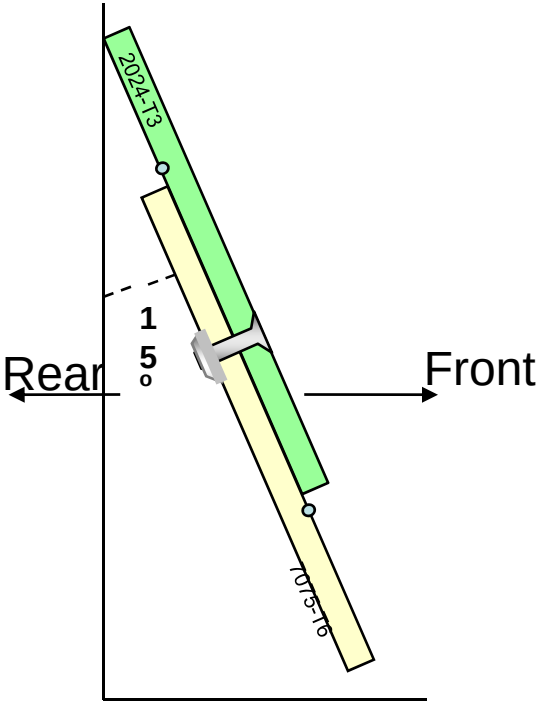
Fastened rivet back should be approximately 1-1/2 times the diameter of the rivet, evenly mushroomed.

Note B: Fastened rivet back should be approximately 1-1/2 times the diameter of the rivet, evenly mushroomed.

NSF & SO2 Panel Orientation in Cabinet







Orient panels 15 degrees from vertical.

NSF & SO2 Evaluation

168 hours = 1 week/7 days

1000 hours = 41.5 days

3000 hours = 125 days~4 months

Evaluate per ASTM D 1654-05

Neutral Salt Fog B117– Duration 3000 hours

- •Check weekly until 1000 hours
- •1000 hours plus, check every 2 weeks, rate and photograph.
- •If a failure occurs – remove, rinse, and photograph or scan panel, and determine the final rating – record.
- •Run sets 2800 hours, 5000 hours, & 10,000
- •photograph, rate, and scan. Record all data.

SO2 ASTM G35– Duration 1000 Hours

- •If a failure occurs – remove, rinse, and rate, then photograph or scan panel
- •At 1000 hours remove 1 set of panels, rate/record, photograph and scan.
- •At 2800 hours remove 1 set of panels, rate/record, photograph and scan
- •Run remaining set to 5000 hours.

Accomplishments to Date

Mar-June

- Panels assembled with candidate fasteners
  - Photographic & Visual documentation
- Panels placed in SO2 and Salt Fog
- Panels shipped for beach exposure testing.

June-Oct

- 1000 Hr SO2 Panels completed, cut for examination and under evaluation
  - SEM analysis performed on Control (current wet install) and Plain (non-coated fastener).
- Panels placed on beach
- 2800 Hr SO2 Panels completed - evaluated
- 1000 Hr B117 panels complete

Oct-Feb

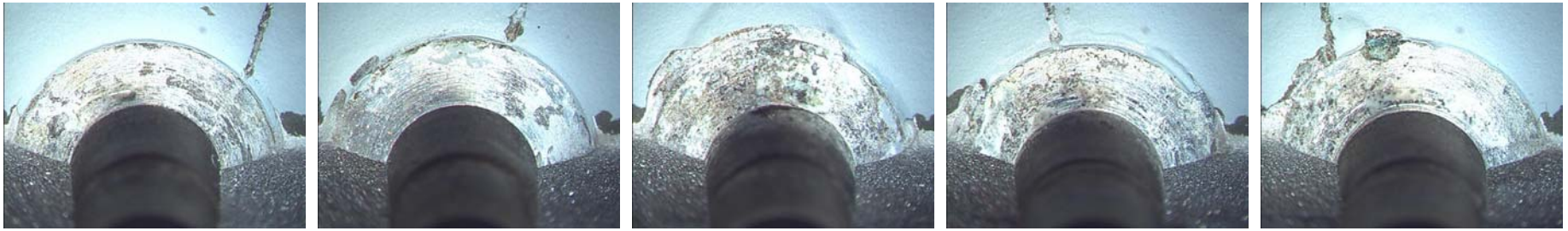
- 2800 Hr B117 Complete – sectioned/being evaluated
- 5000 Hrs SO2 Complete- sectioned/being evaluated

Feb ->

- 5000 Hrs B117
- 10,000 Hr B117

SO2 (G85) Evaluation
1000 Hrs
2856 Hrs

1000 Hours Control- Plain Rivets



17 Weeks Control- Plain Rivets

1000 Hrs SO2 Wet Install

1

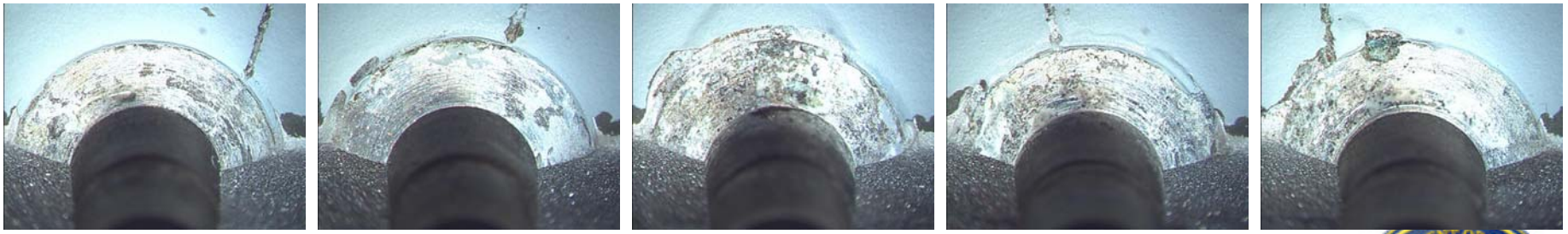
17(2,856 Hrs) weeks Wet Install

NAVAIR

Good

1000 Hours Wet Install with Primer Mag Rich

17 Weeks Wet Install with Primer Mag Rich

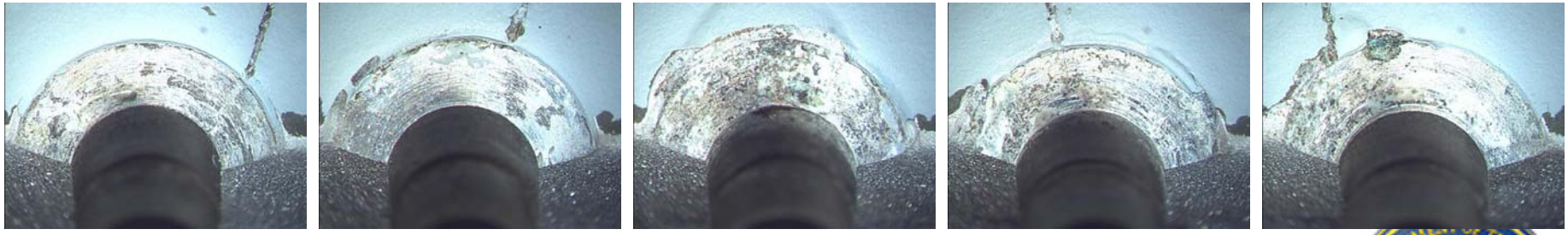


17 Weeks Control- Plain Rivets

1000 Hours SMRC Product

Not seated

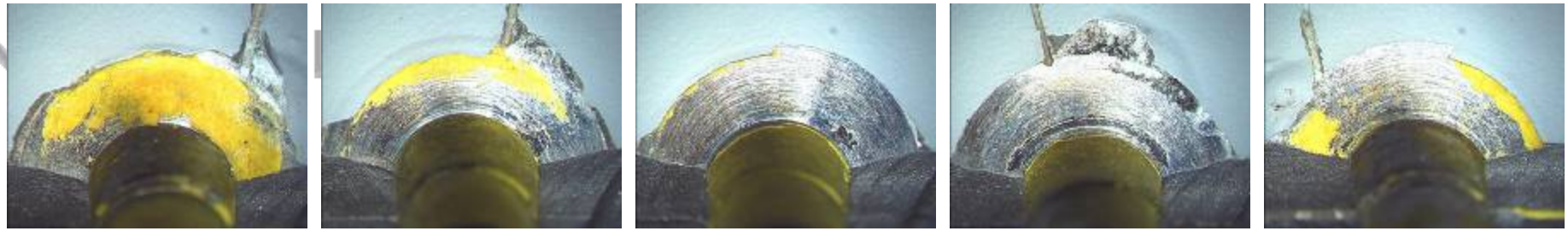
17 Weeks SMRC Product



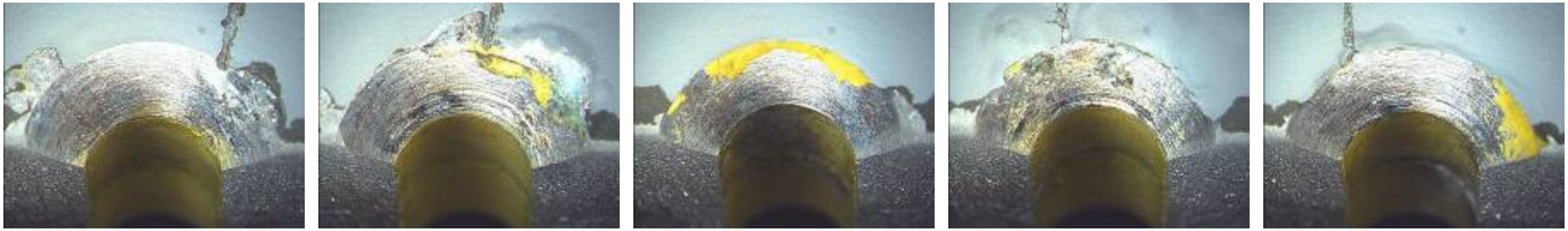
17 Weeks Control- Plain Rivets

Note: Product was precured at time of fastening, fasteners did not seat properly, still performed well-present chromated formulation

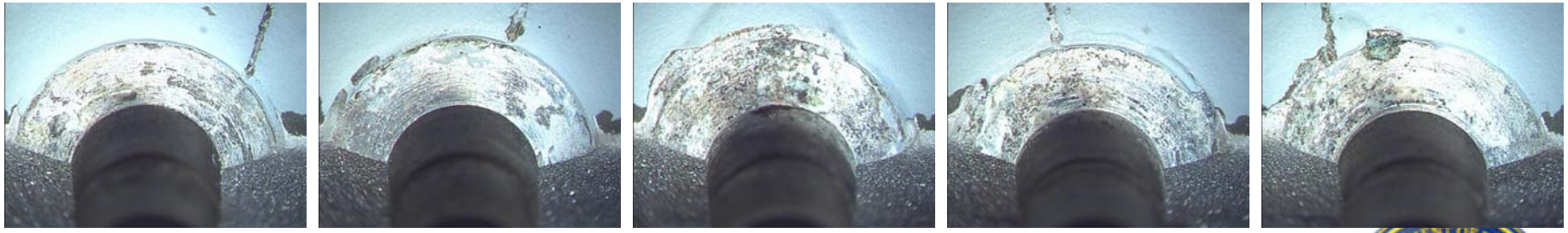
Fair



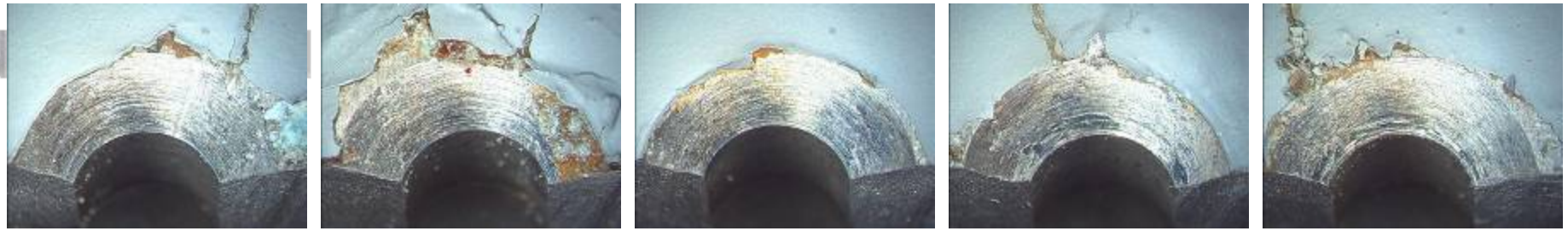
1000 Hours ND Microspheres



17 Weeks ND Microspheres

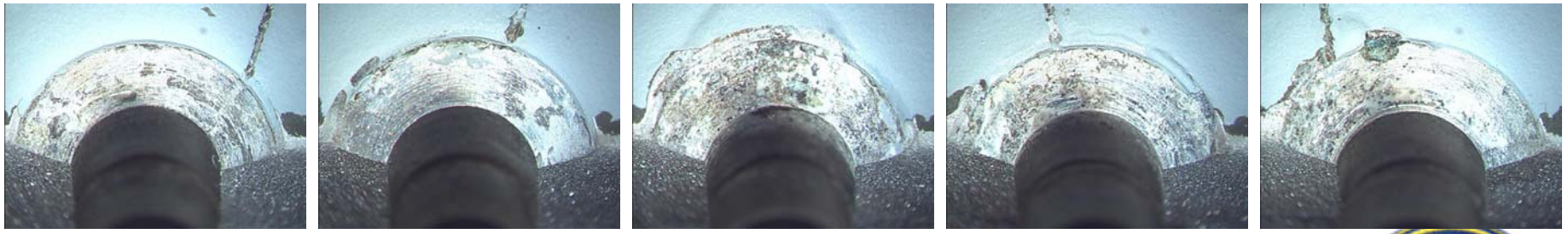


17 Weeks Control- Plain Rivets

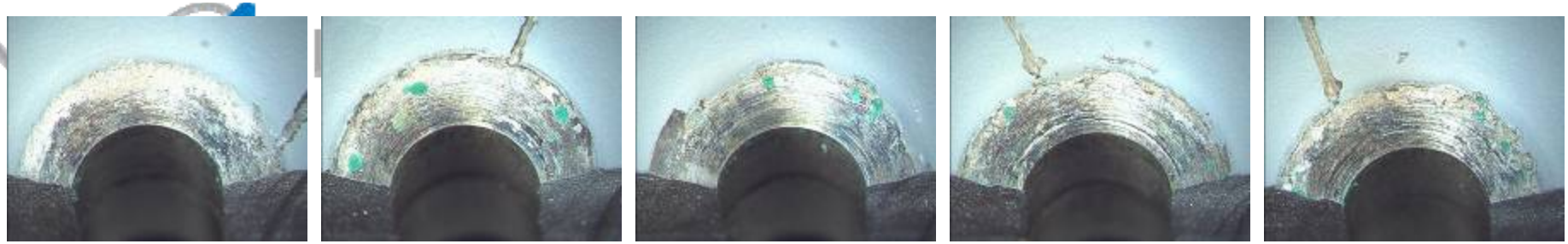


1000 Hours METSS Product

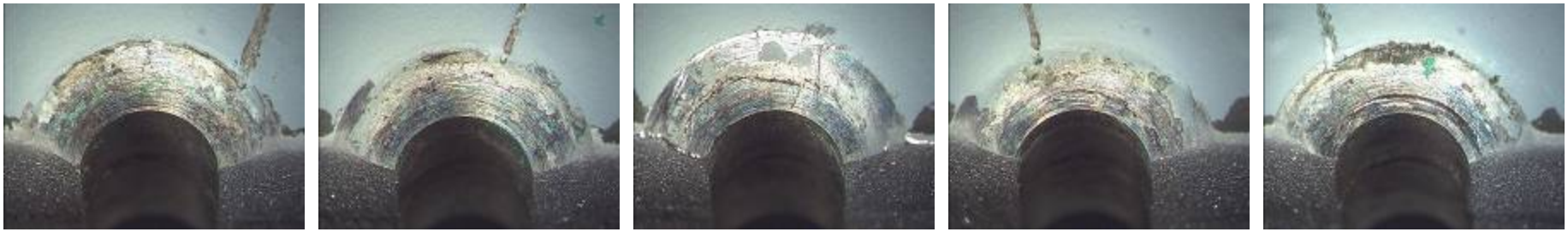
17 Weeks METSS Product



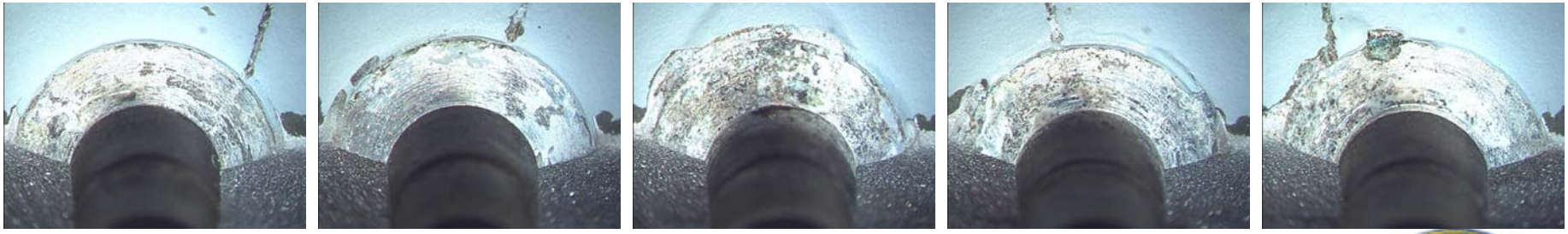
17 Weeks Control- Plain Rivets



1000 Hours NySeal & Magni 565

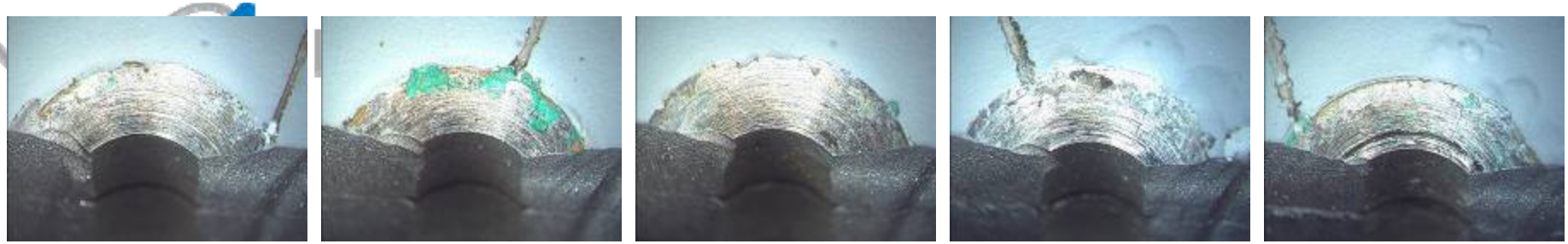


17 Weeks NySeal & Magni 565



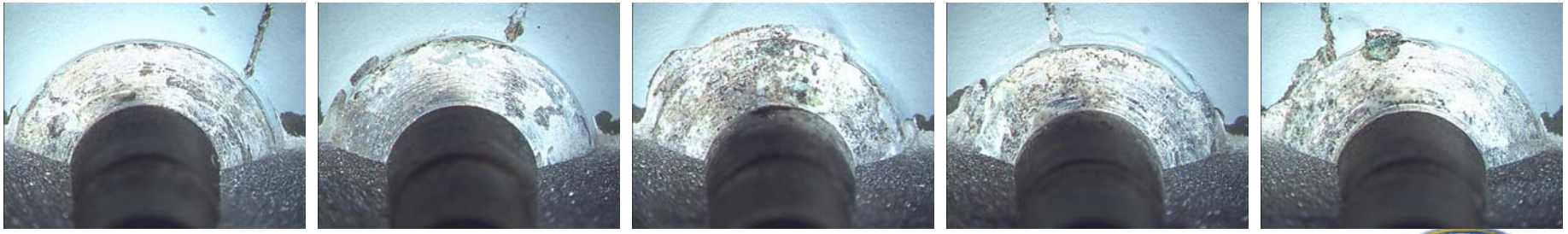
17 Weeks Control- Plain Rivets

Worse



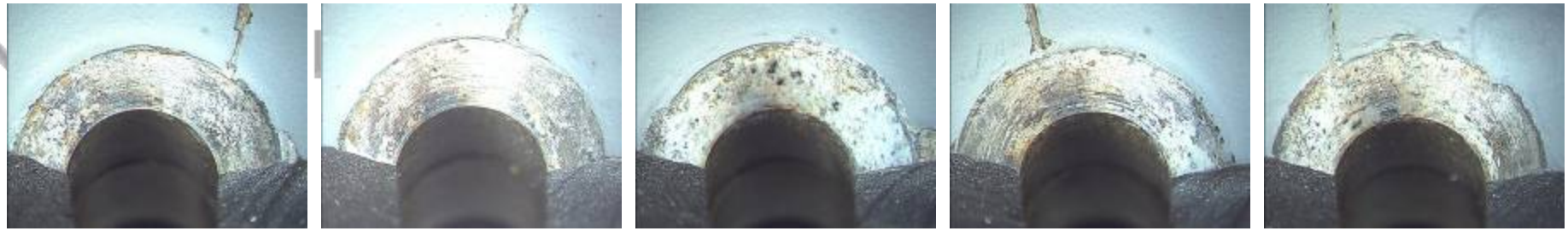
1000 Hours NySeal & Hi-Kote

17 Weeks NySeal & Hi-Kote

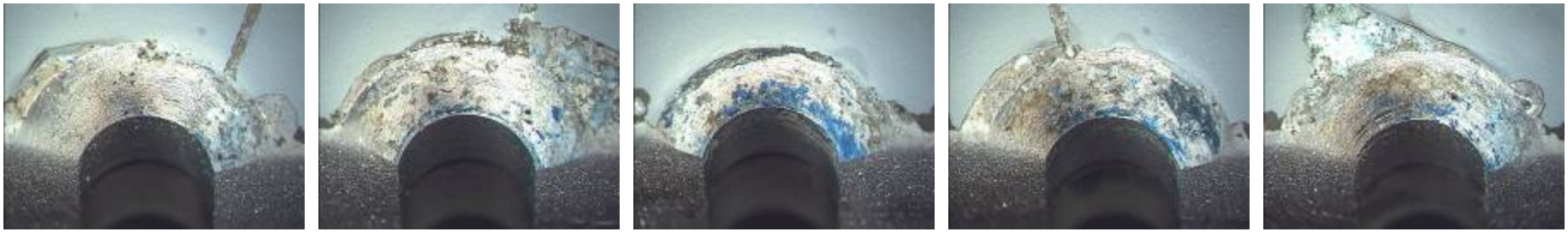


17 Weeks Control- Plain Rivets

Fastener Head Eaten Away



1000 Hours Hi-Kote 1



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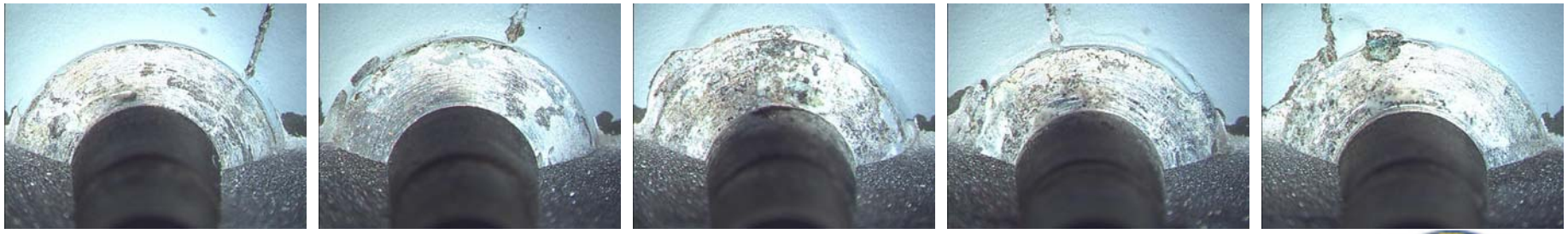
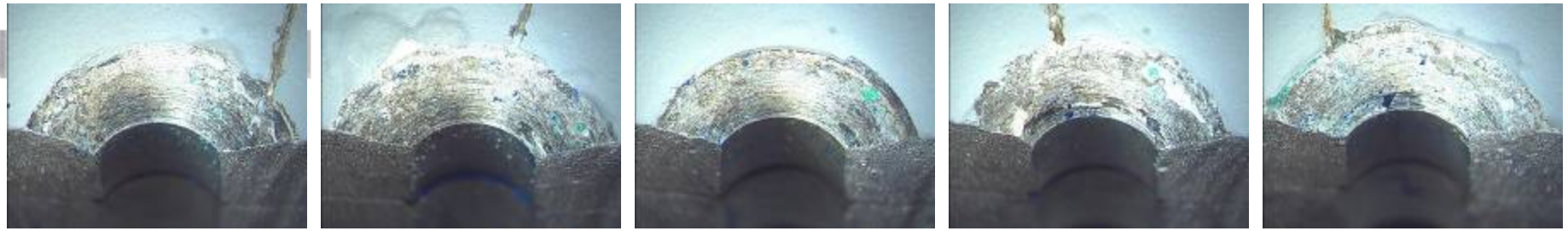
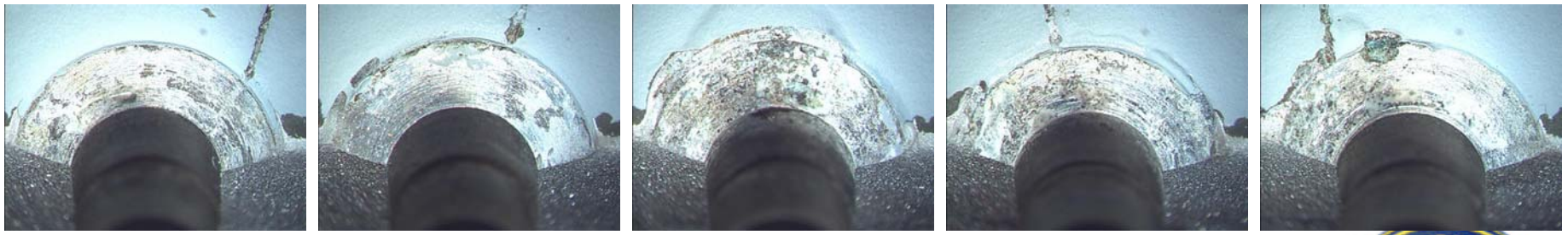


17 Weeks Control- Plain Rivets



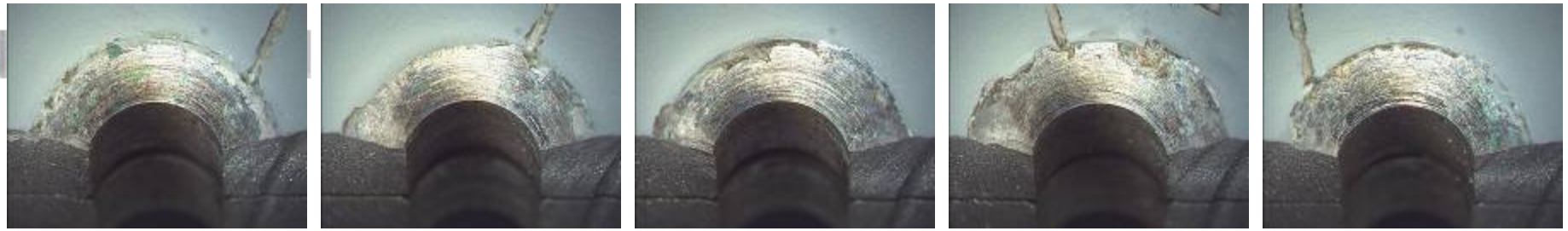
1000 Hours NySeal & Xylan 1424

17 Weeks NySeal & Xylan 1424

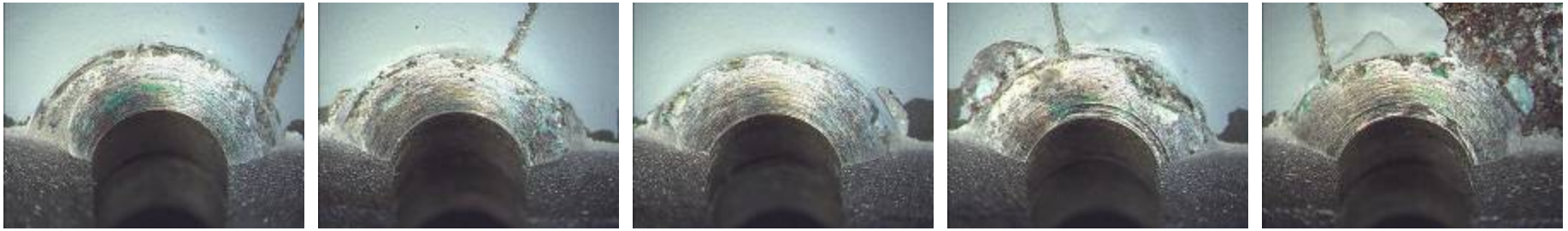


17 Weeks Control- Plain Rivets

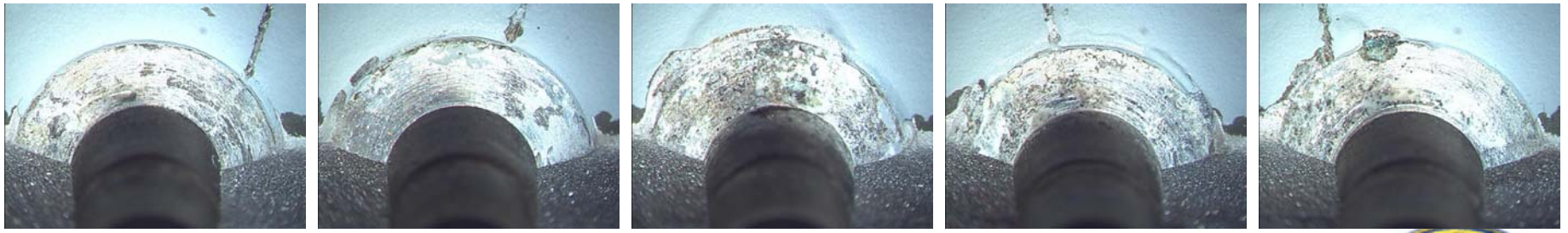
Fastener Head Eaten Away



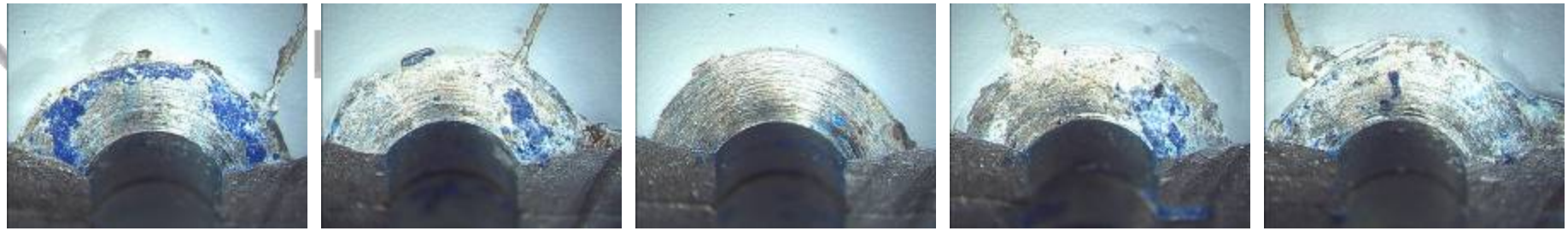
1000 Hours NySeal (Green)



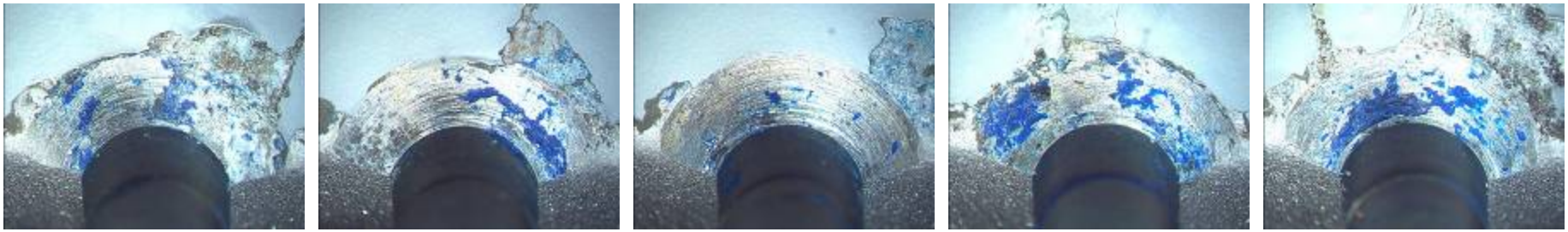
17 Weeks NySeal (Green)



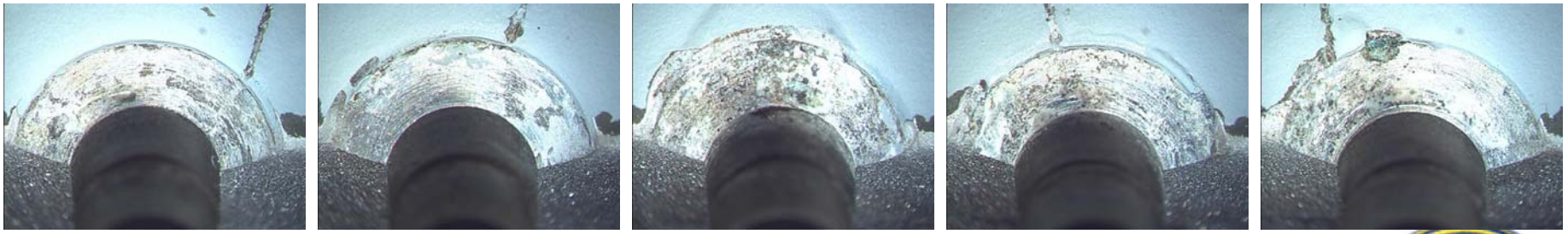
17 Weeks Control- Plain Rivets



1000 Hours Xylan 1424

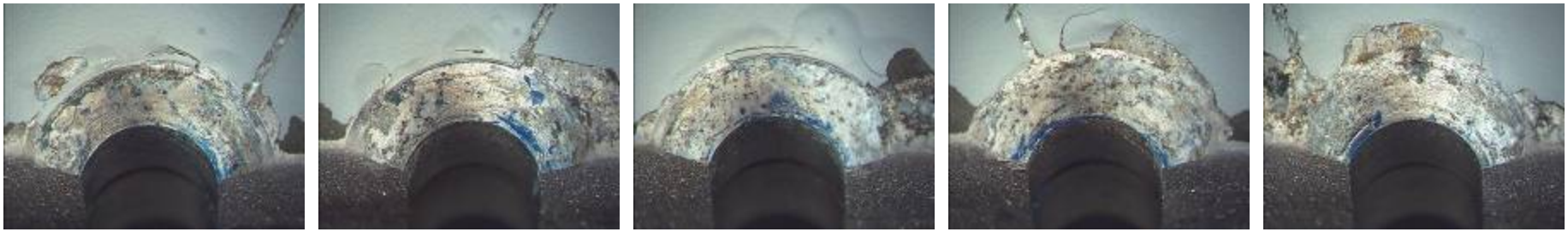


17 Weeks Xylan 1424



17 Weeks Control- Plain Rivets

1000 Hours FluorKote 1



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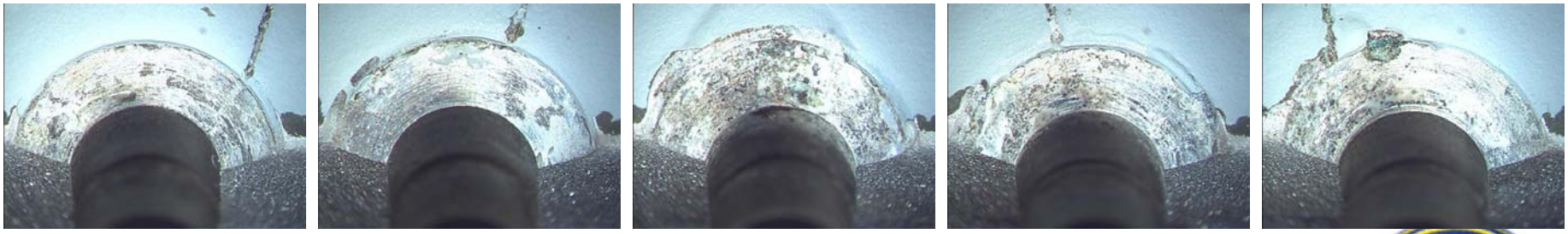
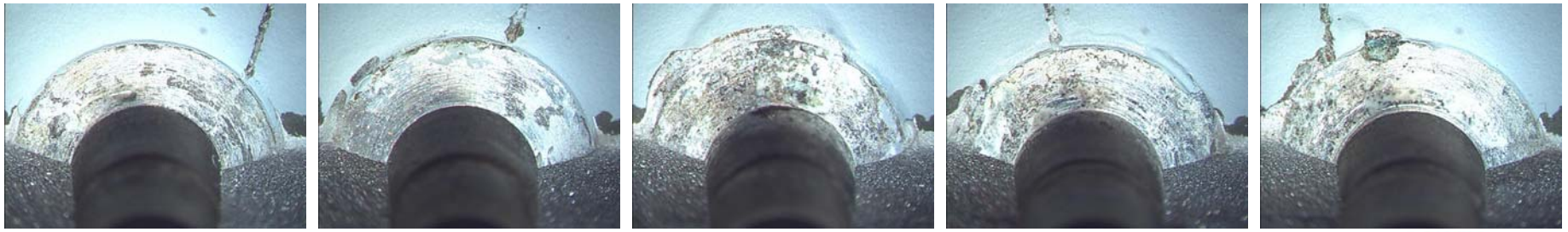


17 Weeks Control- Plain Rivets

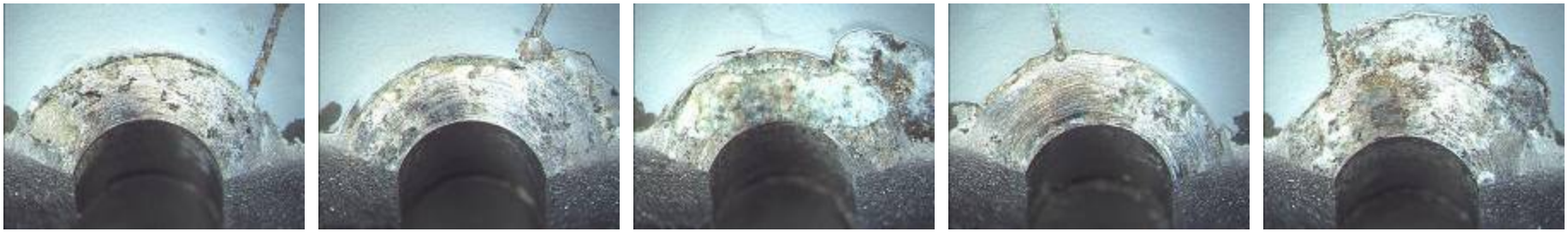
1000 Hours Xylan 1070

17 Weeks Xylan 1070

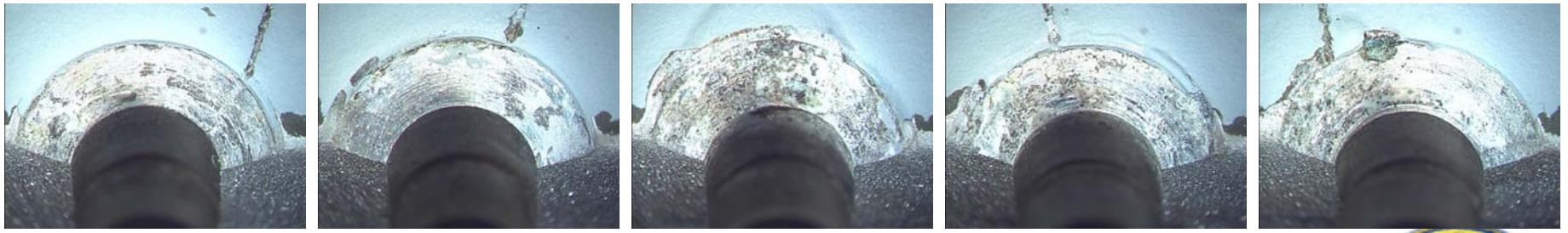


17 Weeks Control- Plain Rivets

1000 Hours Magni 565



17 Weeks Magni 565



17 Weeks Control- Plain Rivets

Preliminary Observations

- **1000 hour B117 did not tell much**
- **From Samples taken out of SO2 & 1000 & 2800 Hours**
  - **Fasteners with a coating of said min thickness mitigate crevice corrosion Need some type of corrosion inhibitor over fastener**
    - Coating must fill gap during fastening to mitigate crevice corrosion
  - **Thinly coated products do not mitigate crevice corrosion**
  - **Fasteners without a corrosion inhibitor included in coating**
    - Heavy corrosive attack, usually resulting in degradation of the fastener head.
  - **It appears as if the dry coating fastener approach may produce candidates perform as well or nearly as well as the current wet installation.**