

A Unique Approach to Marine Non-Skid Surfaces



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 - Flexibility of application for various work environments
 - Application Process
 - Weight
 - Life
 - Cost

Extreme Conditions Faced at Sea



Current Non-Skid Surfaces

- **Types of non-skid currently used**
 - MIL-PRF-24667 Epoxy Non-Skid Coating System for Roll or Spray Application
 - Slip resistant sheet material – large abrasive particles bonded by a tough, durable polymer to a dimensionally stable plastic film. The reverse side is coated with a pressure-sensitive adhesive
 - Broadcast grit – process of capturing grit by scattering in wet paint, then topcoating
- **All provide excellent slip resistance when new**

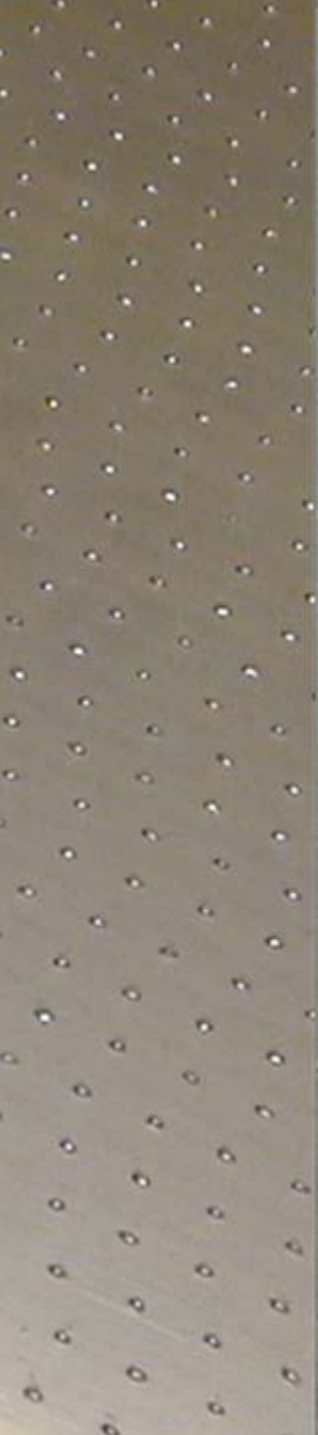
Non-Skid Issues

- **Limited service life:**
 - 18-36 months for MIL-PRF-24667 non-skids
 - 2-3 years for slip-resistant sheet material
 - 3-6 years for broadcast grit
 - Failure mechanisms include delamination, rust bleed, pinpoint rusting, loss of slip resistance when overcoated, ripping/tearing of sheet material
- **Application/processing time**
- **Cost**
- **Weight**

Failure Modes – Delamination



Rust Bleed and Pinpoint Rusting



Cosmetic Appearance Issues



Traditional Non-Skid Application Process

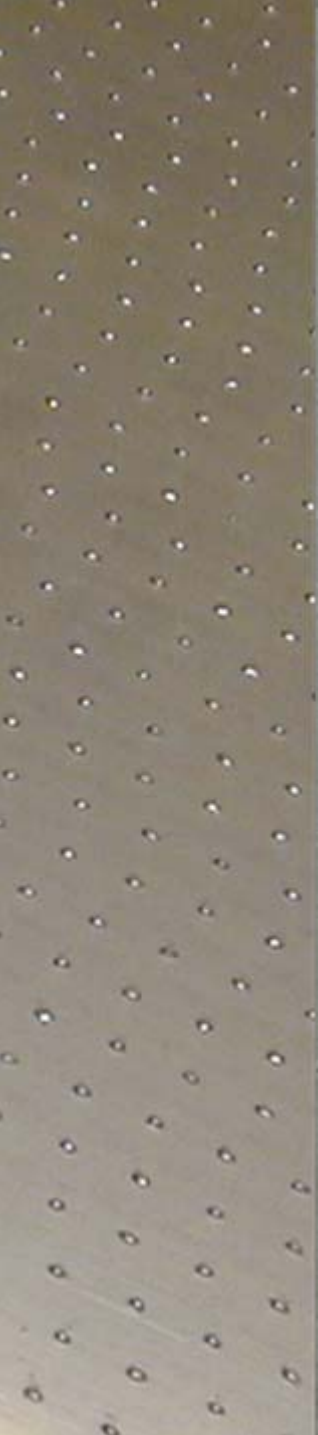
Broadcast Grit (worst case)

- 1 day to prepare surface
- 1 shift to apply clean coat of paint - 1 day to dry
- 1 shift to apply second coat of paint and add grit to this coat - 1 day to dry
- 1 shift to apply final coat of epoxy topcoat - 1 day to dry
- Frequently interruptions due concurrent work in the area, weather, changes in priority, etc.
- Delays increase chances for problems to occur in the application that results in lesser life downstream

New Non-Skid Approach

Laser Deposited Nonskid (LDN)

- Apply welded features using a laser to the substrate metal requiring a non-skid surface rather than painting on a new surface. These features become bumps on the surface which provide a very effective non-skid surface.
- The result is a matrix of slip-resistant particles metallurgically bonded to a base plate for enhanced grip under dry, wet or oily surface conditions.
- Non-slip surface is then coated with a corrosion resistant paint of choice if required.



LDN



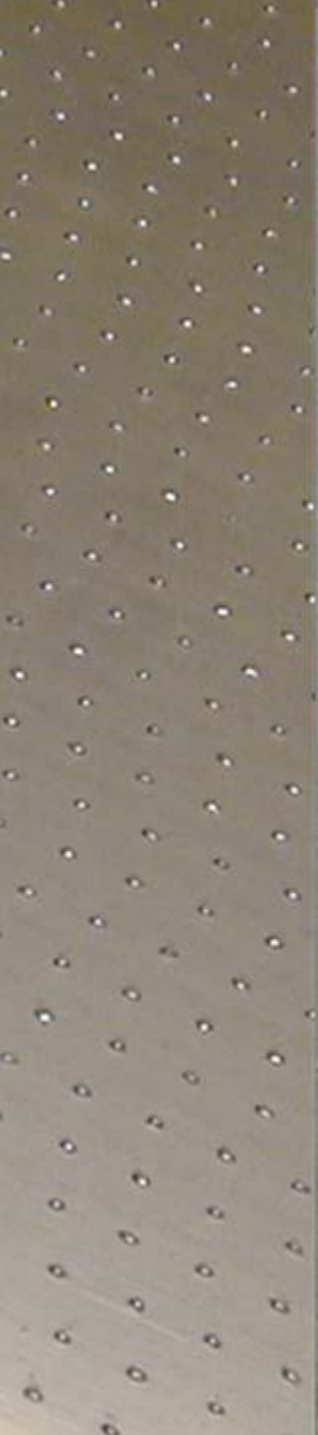
LDN



LDN – Specifics

- Works on any metal surface: Non-skid features can be welded to any ferrous or aluminum surface. We have extensive experience using Ni-Cr alloys, Al alloys, tool steels and alloy steels.
- Flexibility of surface features: Height and width of welded non-skid features can be shaped to work best in a variety of conditions, whether that be foot traffic, aircraft operations or handling heavy equipment.

LDN – Carbon Steel Substrate



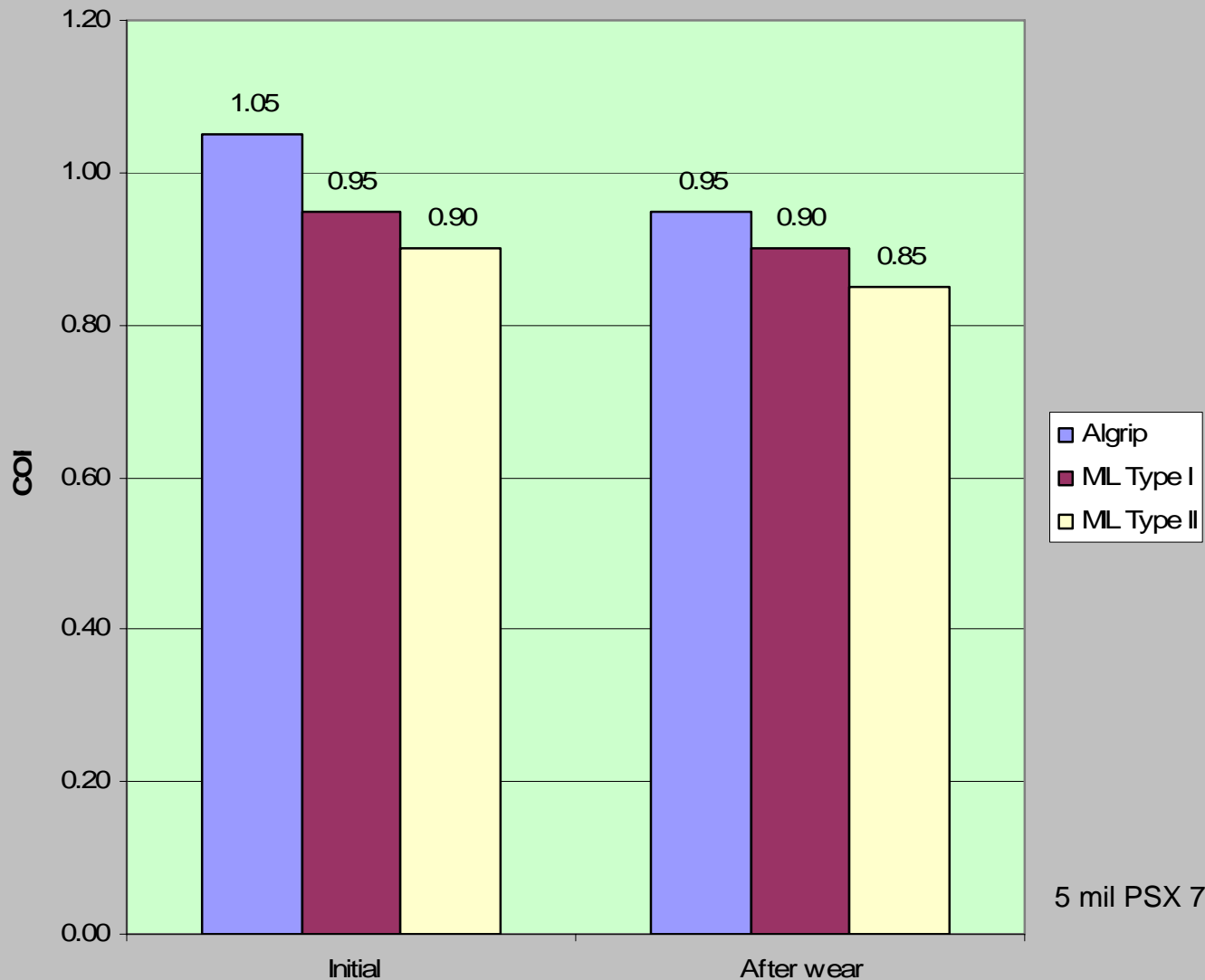
- Ameron Dimetcote 9 Inorganic Zinc Coating on Carbon Steel (.05mm paint coating)
- COF (with a variety of different features) As-Painted (MIL PRF 24667)
 - Dry: 0.95-1.25
 - Wet: 0.9-1.20
 - Oil: 0.95-1.25

NOTE: All COF testing in accordance with Navy Specification MIL-PRF-24667B, Section 4,5.1. and 4.5.1.2.

LDN – Carbon Steel Substrate

Dry COF Test

Dry Surface (ML-PRF-24667B)

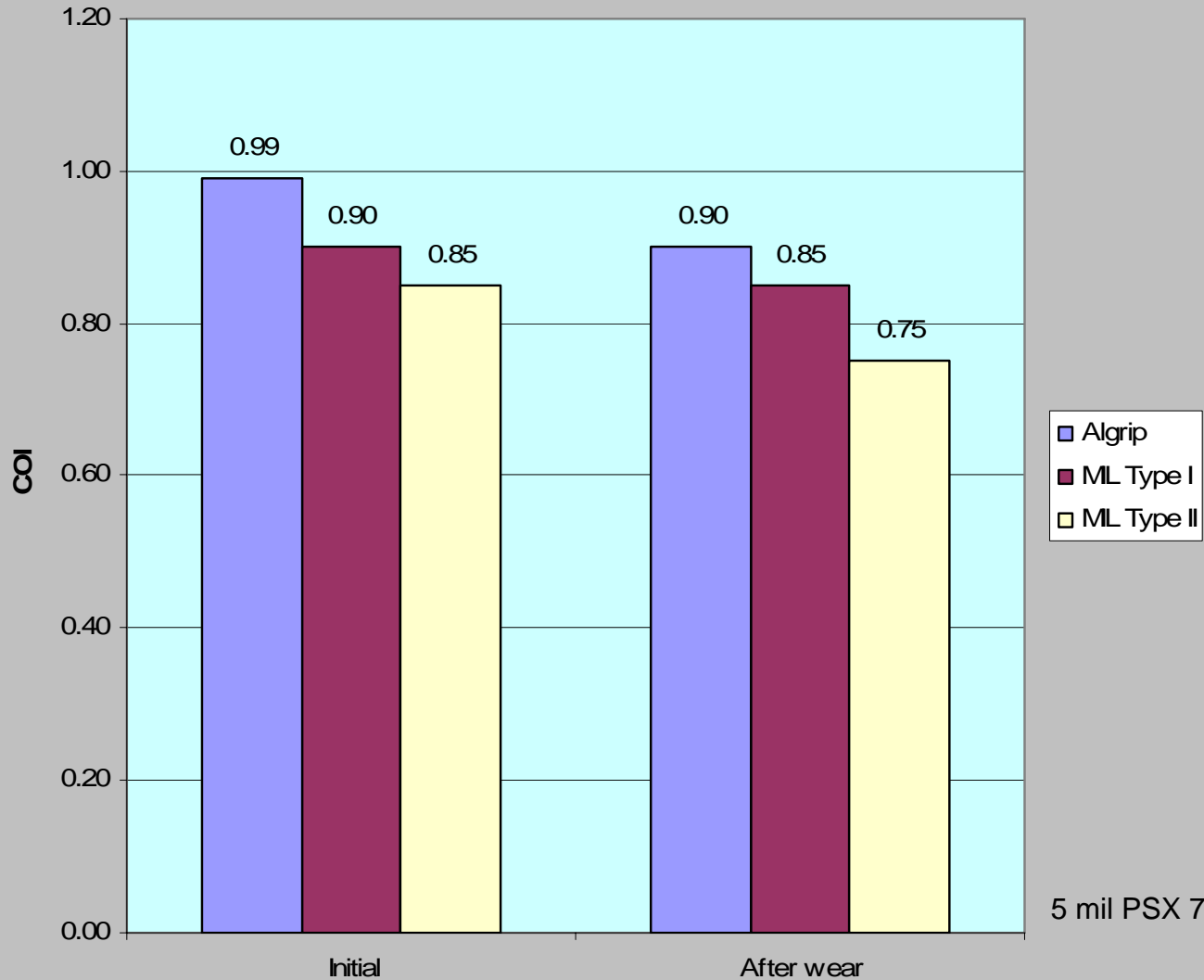


5 mil PSX 700 Coating

LDN – Carbon Steel Substrate

Wet COF Test

Wet Surface (ML-PRF-24667B)

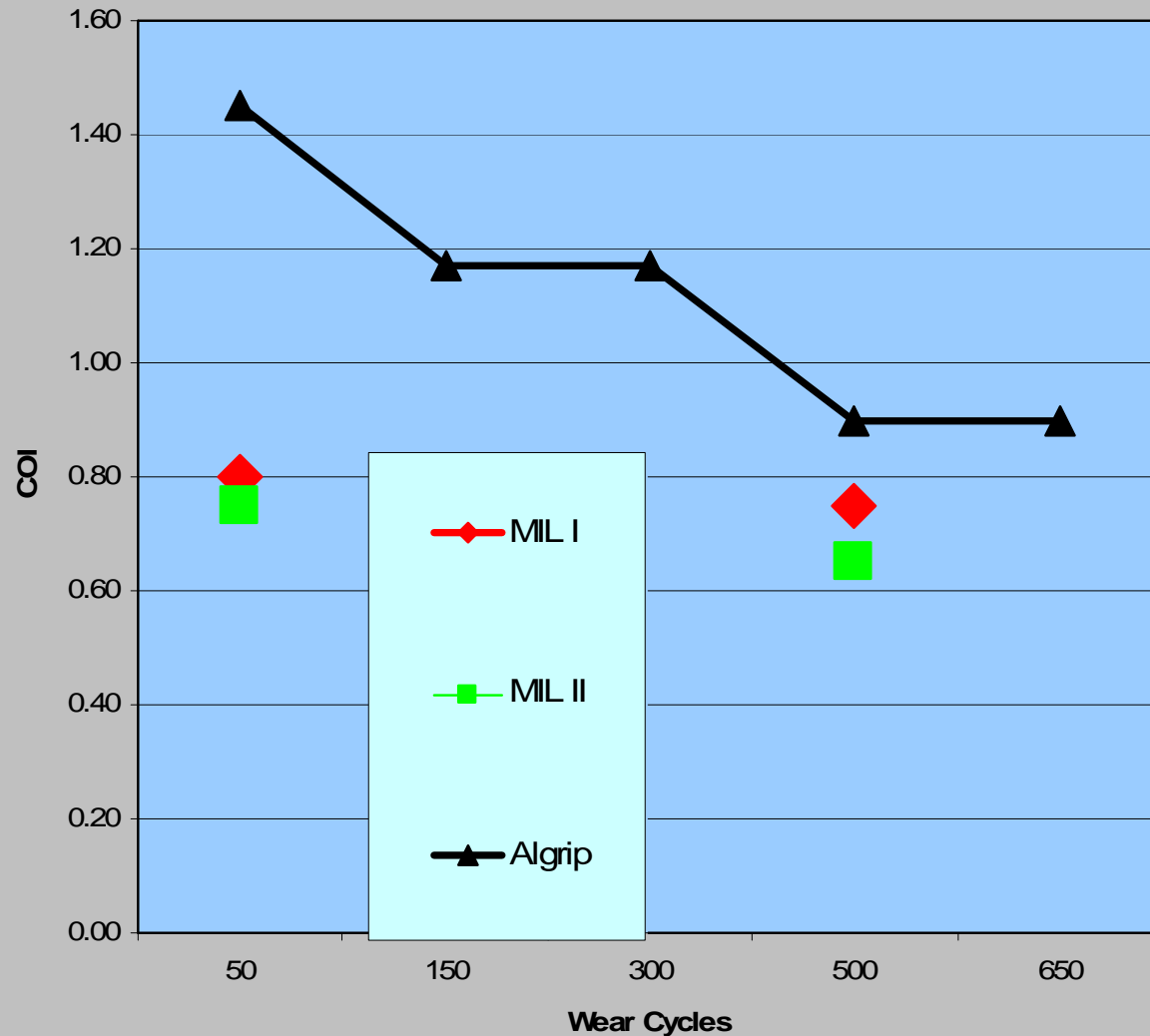


5 mil PSX 700 Coating

LDN – Carbon Steel Substrate

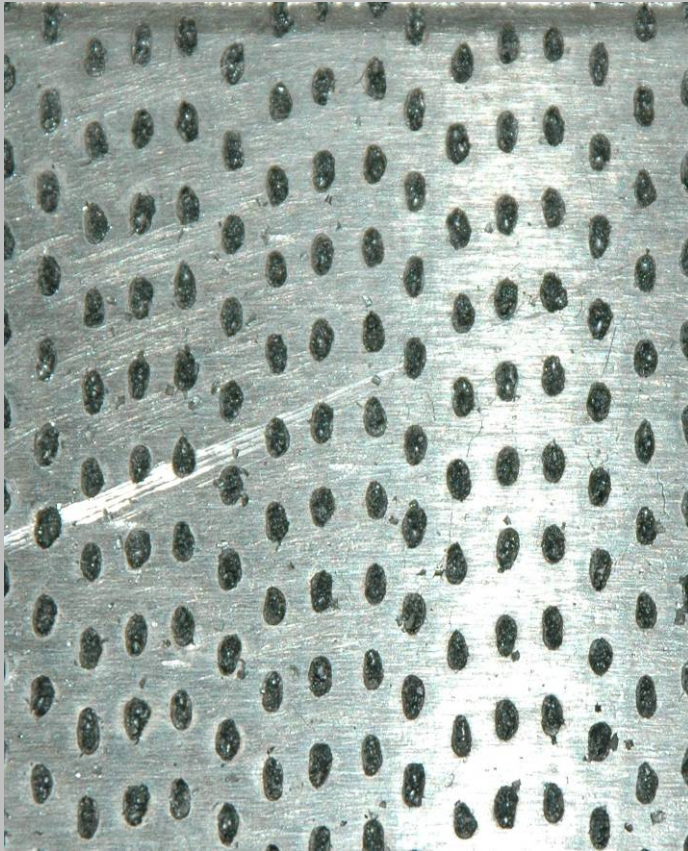
COF vs Wear Cycles

City Surface (ML-PRF-24667B)



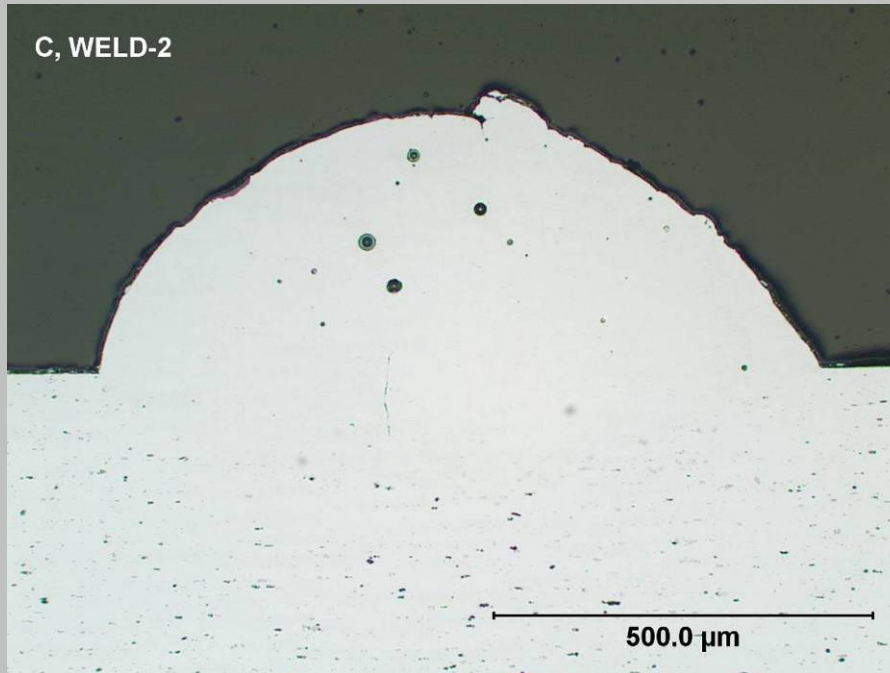
No coating

LDN – 5083 Al Alloy



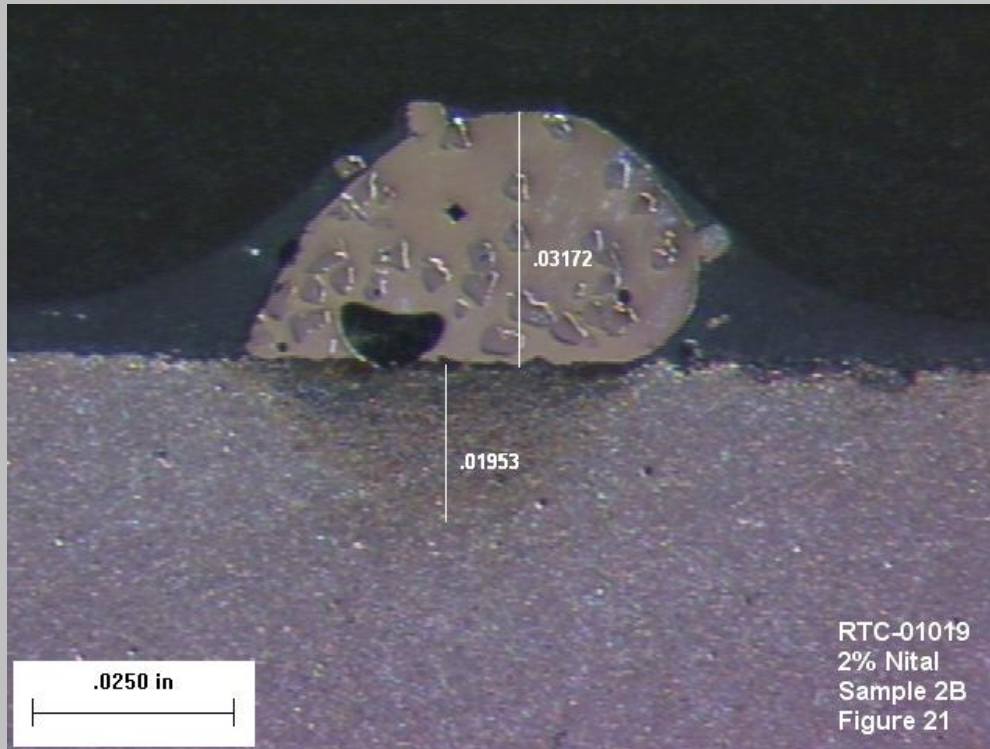
- COF (MIL-PRF 24667B no wear)
 - Dry: 1.65
 - Wet: 1.35
 - Oil: 1.03
- Passes Salt Spray Test (500 hours) per ASTM B117
 - No evidence of galvanic interaction with the features

Typical LDN Feature – Al Substrate



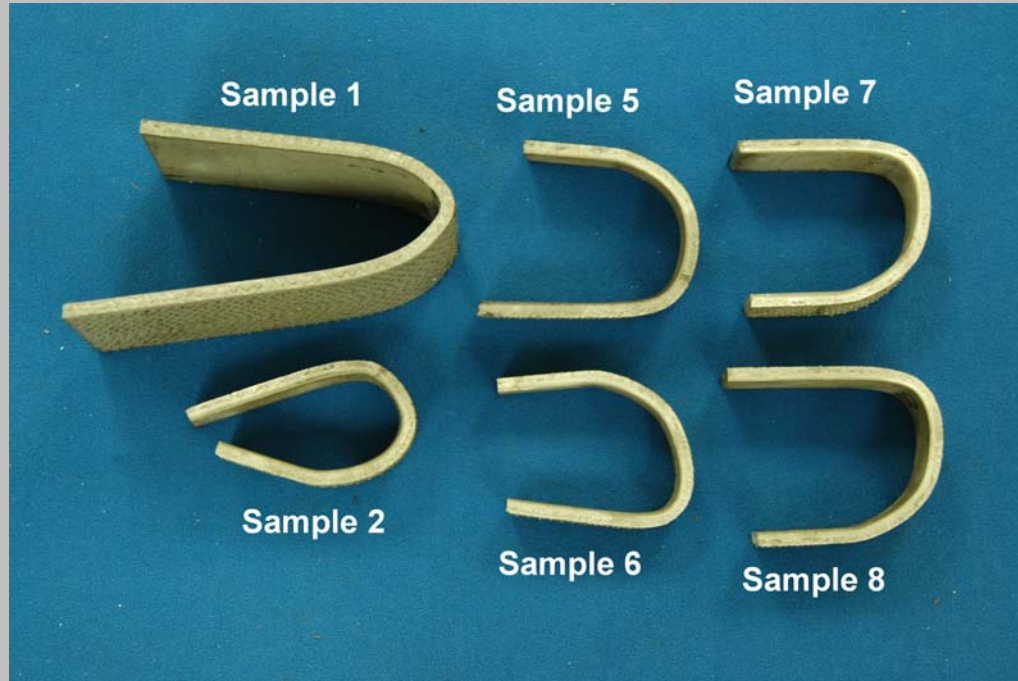
- Typical Algrip feature on 5083 Alloy (unetched)
- Feature height 20 mils (can be extended to 30 mils)
- Depths of penetration from 2 mils to 6 mils
- HAZ typically ranges from less than 2 to 4 mils

Corrosion Resistance



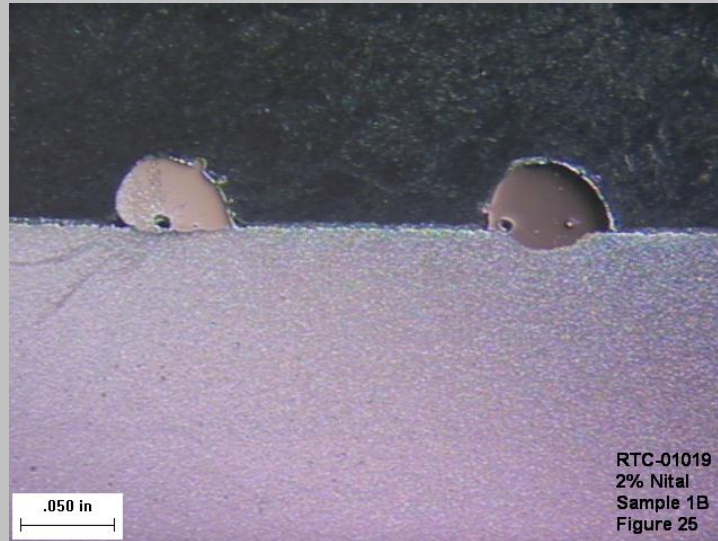
- LDN feature after 1000 hour salt fog test.
- No corrosion noted
 - On feature
 - At juncture
 - On substrate
- Pain intact except at tip of feature.

LDN – No Noted Crack Initiation

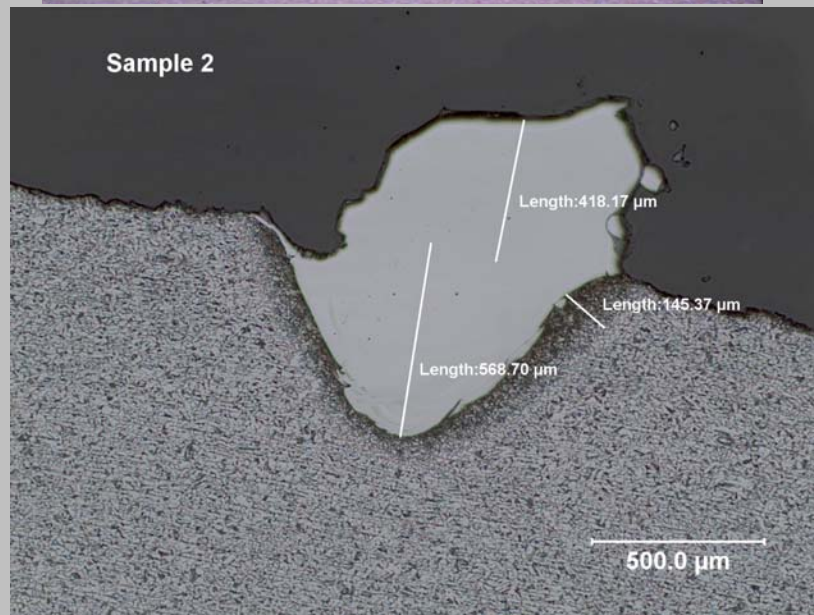


- Initial bend tests conducted on 8 samples
- Sample 2 close to ASTM standard for test
- Under microscopic inspection, no cracks initiated either in features or substrate following tests

Post Bend Test Micrographs



- No cracks created by bend of substrate.



LDN – Flexibility of Application for Different Uses

- Shorter, wider features for heavy equipment handling



- Smaller, taller features for foot traffic

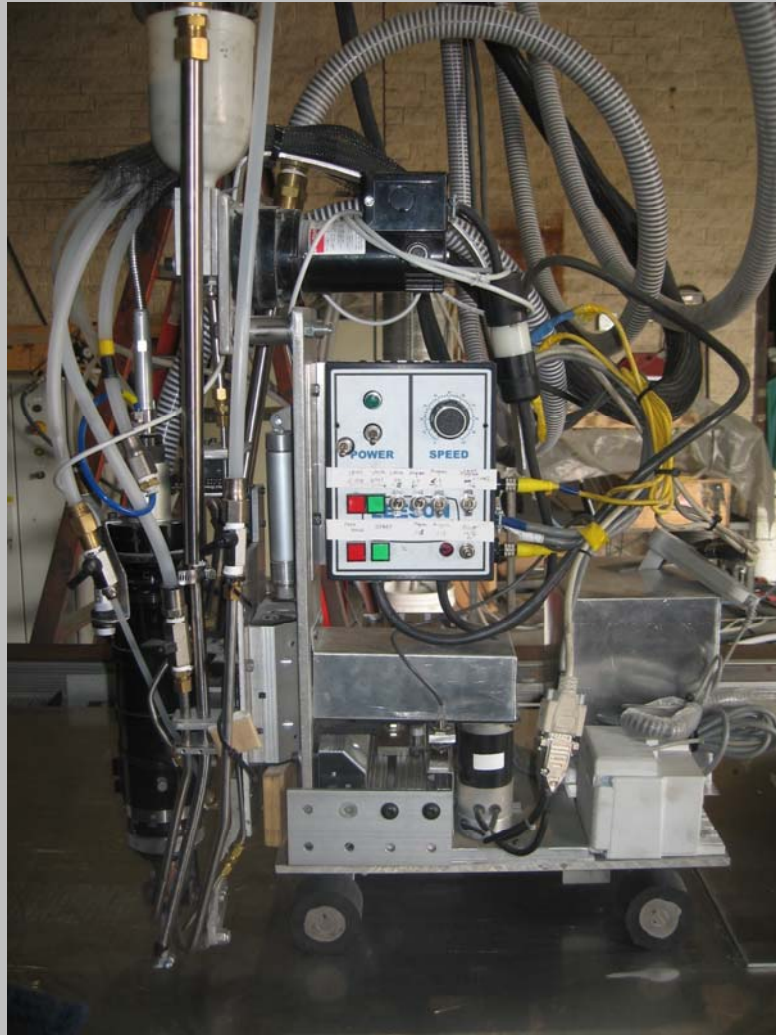
LDN – Application Process

- **New Construction**
 - LDN supplied as pre-applied plate
 - Welding
 - Al features and matched steel features can be welded without any specific preparation.
 - If a weld metal is chosen that is tolerant of the nickel or cobalt alloy content of the feature, they would not have to be removed prior to welding.
 - Worst case - exposed features ground off.

LDN – Application Process

- **Repair**
 - Currently developing portable Algrip machine for onboard and shipyard applications.
 - Working with US Coast Guard to apply AI Algrip to 41 foot vessel.

LDN – Portable Robotic Machine

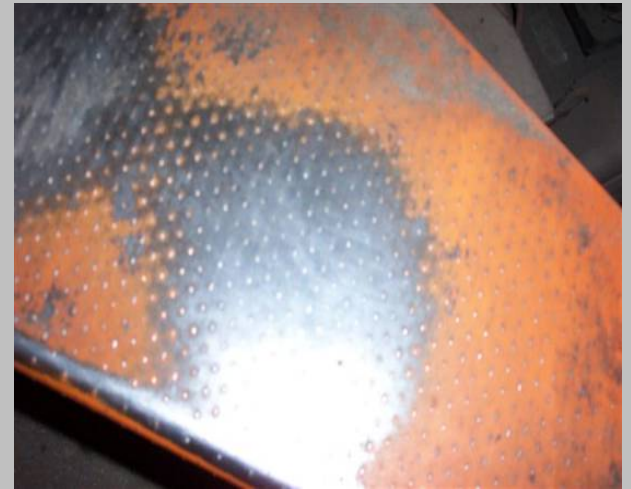


LDN – Users

- Delta Airlines – in cabin service trucks
- Honda America – machining areas
- Pepperidge Farm, Inc. – dry mixing areas
- Simplot Company (largest potato processor)–oily areas
- Bolthouse Farms (leading carrot processor)
- Dryers Ice Cram (Edys) – loading docks
- Con Agra Corporation
- General Mills
- Kraft Foods
- Perdue
- Wegmans Food Markets
- Sara Lee

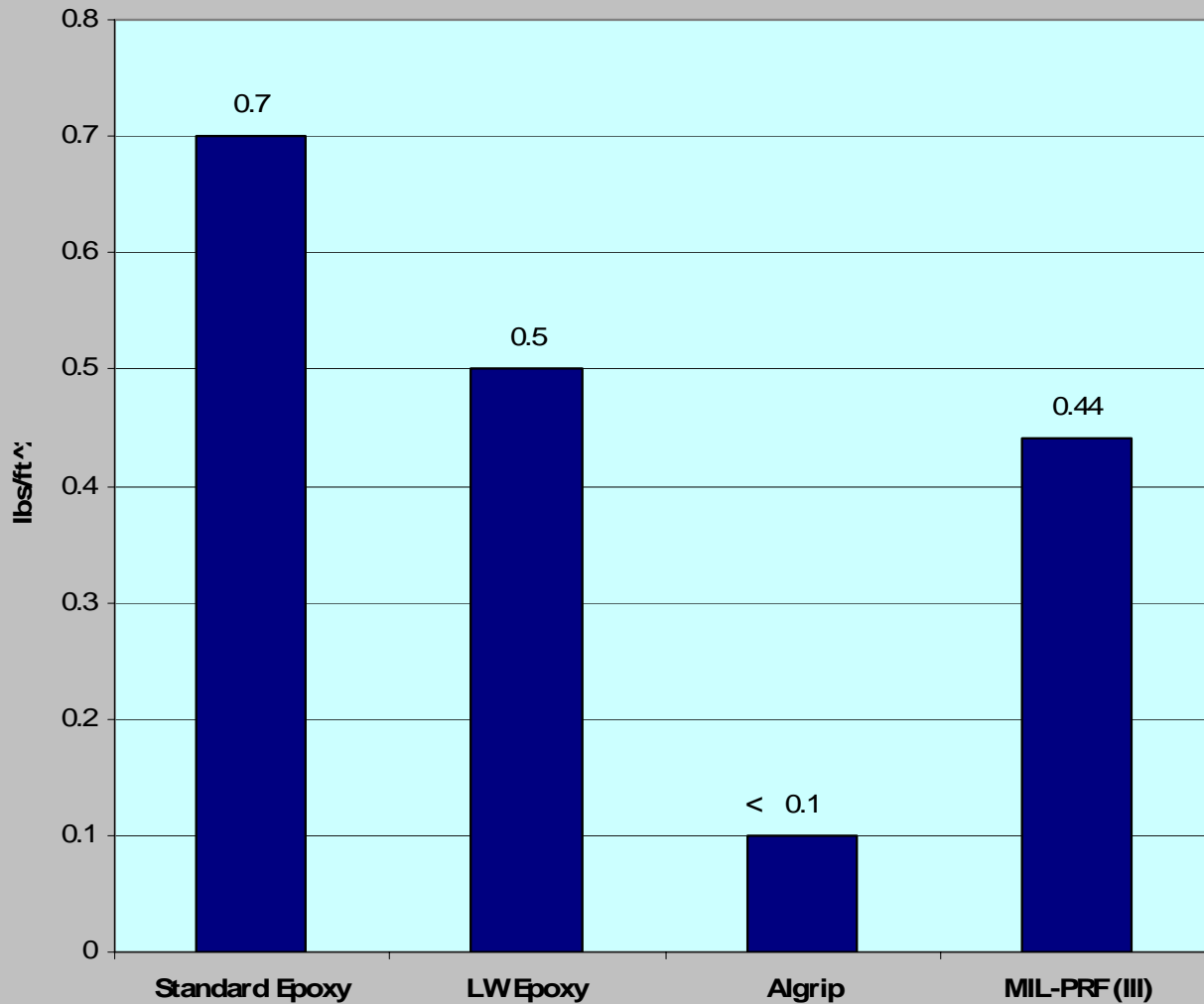
LDN – Durability

5 years of heavy industrial use. Paint faded, but Algrip retains characteristics.



LDN – Weight Advantage

Nonskid Weights



LDN – Non-Skid Problem Solver

	<u>Traditional Non-Skid</u>	<u>Algrip</u>
Weight	0.5 lbs/ft ²	<0.1 lbs/ft ²
Life	<2 years	>5 years
Application Process	time-intensive	Minutes for features
Coeff. of Friction	Satisfactory	Satisfactory
Cost	comparable	comparable

Questions?

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Thank you

Corrosion Resistance



- Algrip feature after 1000 hour salt fog test.
- No corrosion noted
 - On feature
 - At juncture
 - On substrate
- Corrosion on this plate is all from uncoated sides.

Algrip – Carbon Steel Substrate

COF After Painting with 5 mils PSX 700 and Wear Testing

Wear Cycles	Dry	Seawater	Engine Oil - #1	Engine Oil - #2
50	1.05	0.99	0.70	0.73
200	----	----	0.66	0.66
350	----	----	0.77	0.77
500	0.95	0.9	0.66	0.66
650	----	----	0.77	0.73

(Oily Tests from previous product.
New Algrip greatly improved as
seen in previous slides.)