Demonstration of a Zirconium-Based Pretreatment as a Non-Chrome Alternative to MIL-DTL-81706

AFCPCO Corrosion/Non-Chrome TIM • 9-11 March 2026 • Spokane

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Overview

- Introduction
- Objective
- Updates to MIL-DTL-81706
- Test Plan
- Results
- Conclusion
- What's Next
- Questions

Introduction

Several drivers to reduce use of toxic metals:

- Hexavalent chromium (Cr VI) is a Class 1 carcinogen
- Stricter OSHA regulations
- Toxic Metal Reduction in Surface Finishing of Army Weapon Systems (PP-2-02-04)
- Trivalent chromium (Cr III) alternatives are still toxic

Introduction

Zirconium (Zr) pretreatments:

- Zr alternatives studied more in depth in recent decades.
- Advantages include milder bath pH and cost savings as thinner coatings are needed for sufficient corrosion inhibition.
- Commercially available, but not widespread use in DOD.

Objective

Facilitate the use of Zr pretreatments within the DOW:

- Update MIL-DTL-81706 to Rev C
- Obtain commercially available Zr pretreatments
- Devise a test plan and run qualification testing
- Leverage results to conduct demonstrations
- Update QPL for MIL-DTL-81706 Rev C

Updates to MIL-DTL-81706

INCH-POUND

NOTE: This draft dated 27-June 2025, prepared by Naval Air Systems Command, has not been approved and is subject to modification.DO NOT USE PRIOR TO APPROVAL (DoD Project No. MFFP-2025-003)

MIL-DTL-81706C
DRAFT
SUPERSEDING
MIL-DTL-81706B
w/AMENDMENT 1
02 May 2006

DETAIL SPECIFICATION

CHEMICAL CONVERSION AND PRETREATMENT MATERIALS
FOR COATING ALUMINUM AND ALUMINUM ALLOYS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers chemical conversion coatings and pretreatment materials used in the formation of coatings by the reaction of the material with the surfaces of aluminum and aluminum alloys.

1.2 Classification. The chemical conversion materials and application methods are of the following types, classes, material forms, application methods, and grades.

1.2.1 Types. The chemical conversion coating and pretreatment materials are of the following types (see 3.2 and 6.2):

Type I - Compositions containing hexavalent chromium.
Type II - Compositions containing no hexavalent chromium.
Type III - Compositions containing no chromium.

1.2.2 Classes. The chemical conversion and pretreatment materials are of the following classes (see 6.1.1 through 6.1.3, and 6.2)

Comments, suggestions, or questions on this document should be addressed to Commanding Officer, Naval Air Warfare Center Aircraft Division Lakehurst, System Standardization and PHS&T Branch, Code BL32600, B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to NAVAIR-Standardization@us.navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A AREA MFFP

Type I - Compositions containing hexavalent chromium.
Type II - Compositions containing no hexavalent chromium.
Type III - Compositions containing no chromium.

Class 1A - For maximum protection against corrosion, painted or unpainted.
Class 3 - For protection against corrosion where low electrical resistance is required.
Class 4 - For protection against galvanic corrosion, primed (with/without topcoat system) only.

Method E - Spray, multi-step conversion coating process
Method F - Brush or wipe-on, multi-step conversion coating process
Method G - Immersion, multi-step conversion coating process

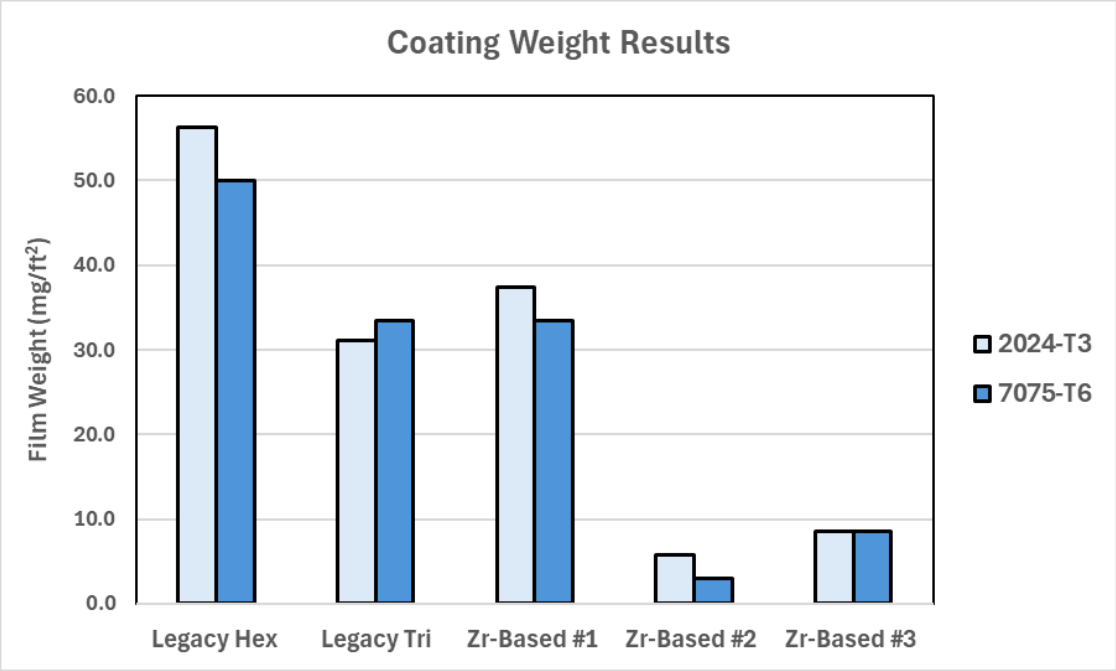
1.2.5 Grade. Chemical conversion coating and pretreatment materials are deposited according to the following grades (see 6.1.5 and 6.2):

Grade N - Non-electrolytic.
Grade E - Electrolytic with a maximum current density of 0.800A/ft^2 (0.086 A/dm^2) with the working part acting as a cathode.

Test Plan

Tests	Pretreatment
General Properties	Coating Weight
Corrosion	ASTM B117
	Beach exposure
Adhesion	Dry Tape
	Wet tape
	Pull-off strength
E-Chem	Electrical Contact Resistance

Results: Coating Weight



Zr Pretreatment #1

Zr Pretreatment #2

Zr Pretreatment #3

Results: Corrosion- 168 Hrs. ASTM B117

Legacy Hex-Cr

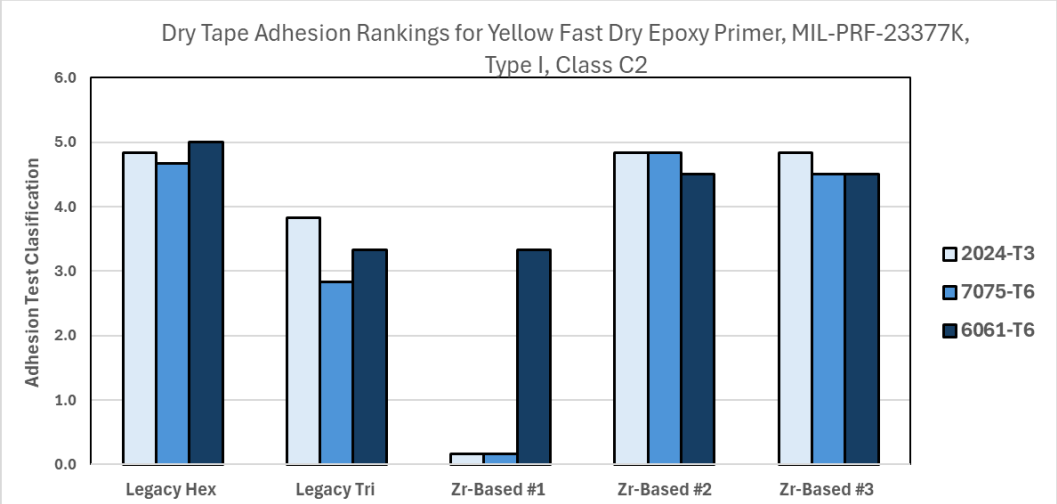
Legacy Tri-Cr

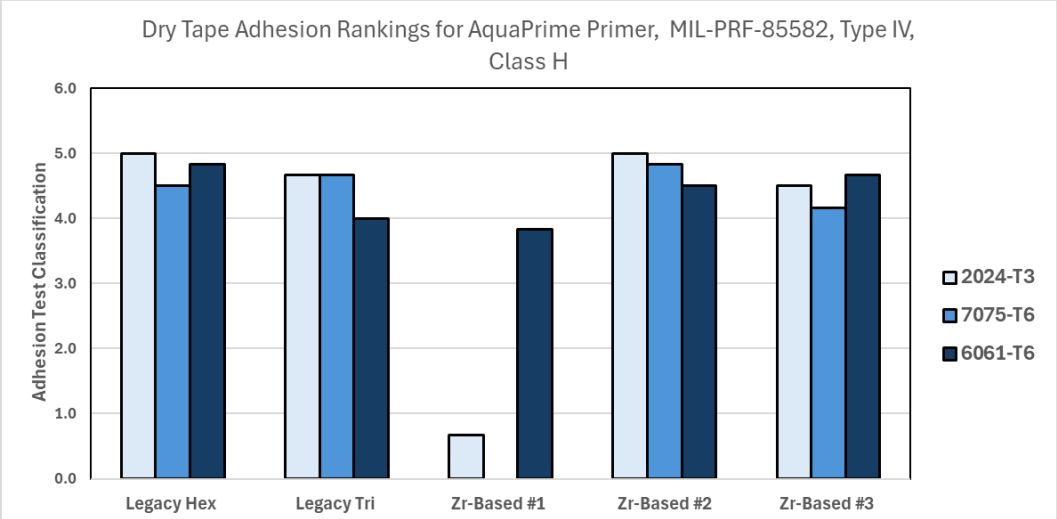
Zr Pretreatment #1

Zr Pretreatment #2

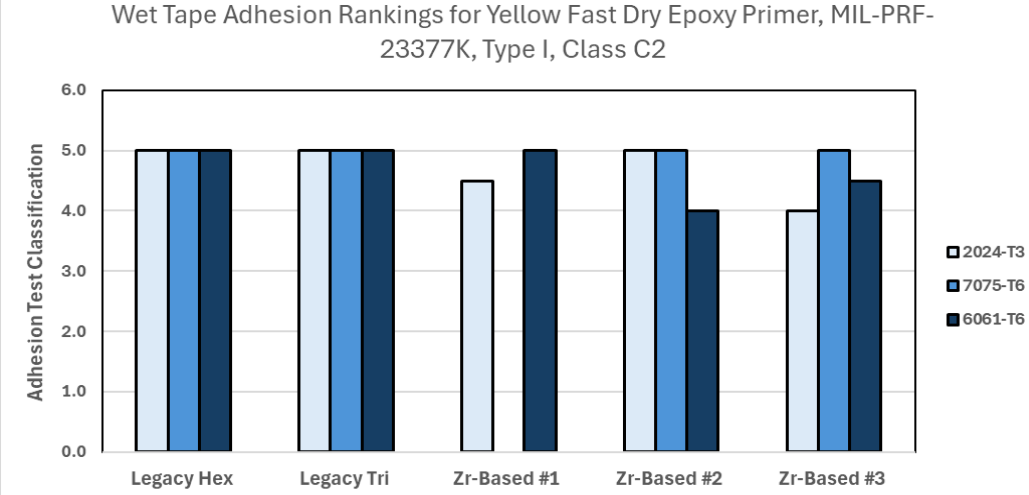
Zr Pretreatment #3

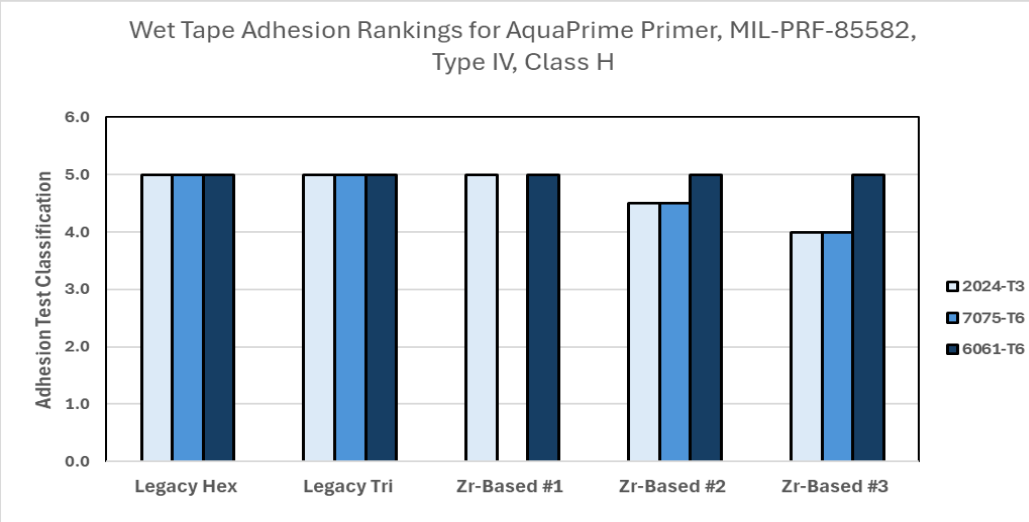
Results: Dry Tape Adhesion



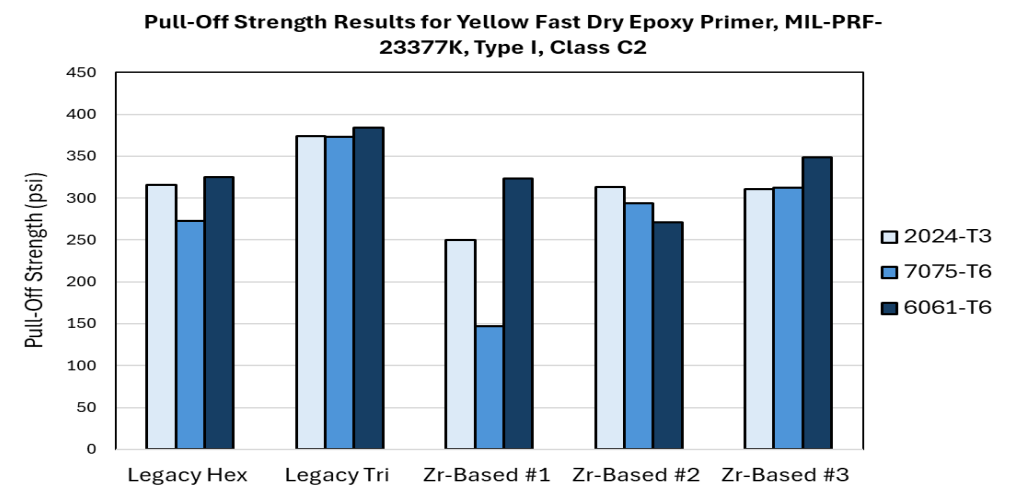


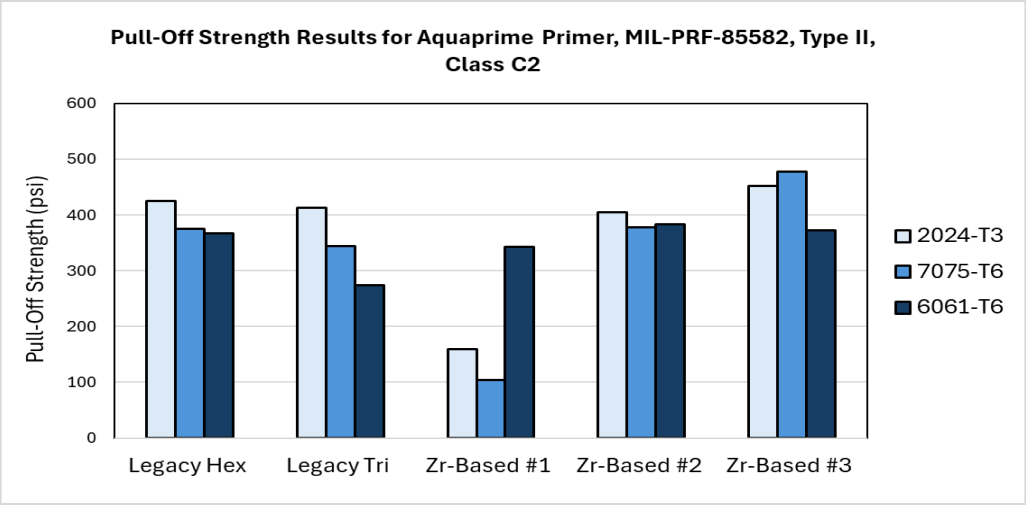
Results: Wet Tape Adhesion



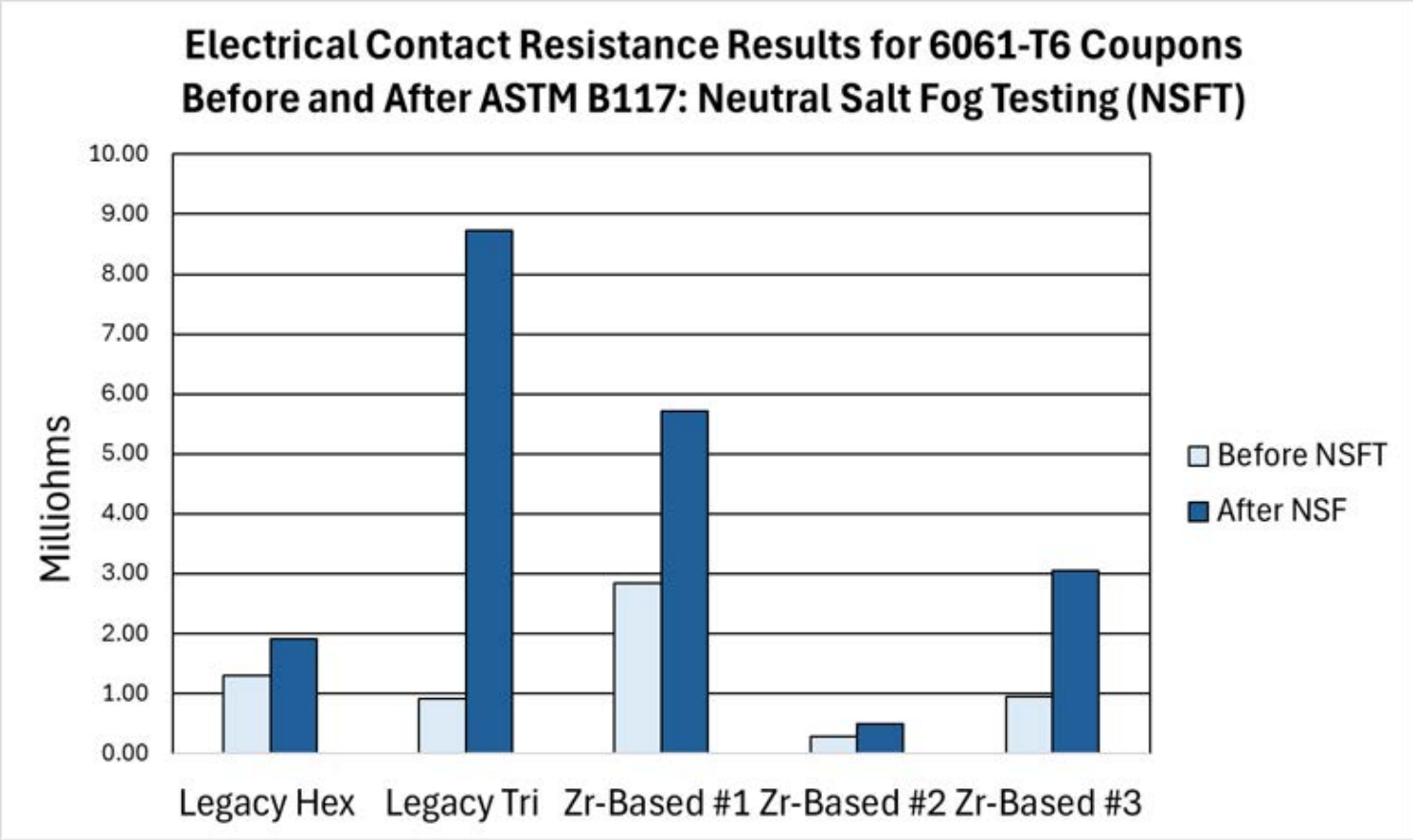


Results: Pull-off Strength





Results: Electrical Contact Resistance



Conclusion

- Zr-based pretreatments show potential as alternatives for chromium containing ones for the pretreatment of aluminum alloys.
- However, more work is needed before these products can be fully qualified to the new revision of MIL-DTL-81706.

What's Next

- Continue testing:
  - o Shelf-life testing
  - o Galvanic corrosion
  - o Monitor beach exposure
- Incorporate comments/ feedback into MIL-DTL-81706

Thank You

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