



# EVALUATION OF HAP-FREE CHEMICAL PAINT STRIPPERS AS AN ALTERNATIVE TO METHYLENE CHLORIDE

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**Sustainable Painting  
Operation for the  
Total Army  
SPOTA**

**2006**  
**JSEM**  
Joint Services Environmental Management  
Conference & Exposition

*Cleared for Public Release*



# OUTLINE



- ✓ Objective
- ✓ Background
- ✓ Experimental Procedures
  - Immersion Tests
  - Evaluation Method
- ✓ Immersion Performance
  - Round 1
  - Round 2
  - Components
- ✓ Repaintability
- ✓ Reduced Temperature Performance
- ✓ Conclusions and Recommendations





# OBJECTIVE



Investigate the feasibility of replacing methylene chloride based paint removal methods with HAP-free chemical paint strippers in order to comply with upcoming NESHAP requirements





## BACKGROUND

### Primary Sites using Methylene Chloride Paint Strippers\*:

- Anniston Army Depot, Anniston Alabama
  - Largest Immersion stripping operation
    - Five paint stripping vats
  - Pen Strip NPX w/ floating wax layer
    - Reported usage: 20K gal/yr
  
- Corpus Christi Army Depot, Corpus Christi, TX
  - Crest Strip #7
    - Primarily for manual stripping of rotor blades
    - Reported usage: 1.1K gal/yr
  
- Letterkenny Army Depot, Letterkenny, PA
  - Crest Strip #28 for manual stripping
  - Reported usage: 14.75 gal/yr

\* SPOTA "Depainting Assessment Report"

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## BACKGROUND

### Facility Specific Performance Requirements from Depainting Army Test Protocol (ATP)

#### Immersion Process:

- ❖ ANAD/TACOM: Paint stripper must remove **100%** of the CARC system within **30 minutes without brushing**.
- ❖ CCAD/AMCOM: Paint stripper must remove **90%** of an epoxy/polyurethane paint system from the substrates **within one hour** without brushing.
- ❖ LEAD/AMCOM no immersion requirement stated



# EXPERIMENTAL PROCEDURE

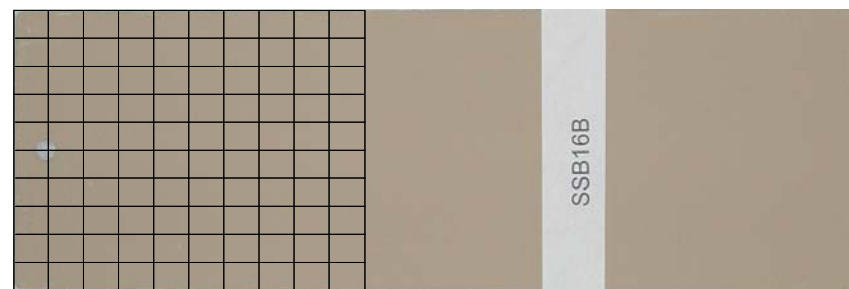
## Immersion Tests:

- HAP-free products were heated to between 150° -170° F
- Two painted panels of each CARC type were immersed for **30 minutes**
- Removed and rinsed with agitated DI water



## Evaluations:

- All panels were photo-documented
- Amount of coating “removed” was rated using ASTM D 1654 procedure B
- Score reported as **percent of area removed for each layer of paint**





# IMMERSION PERFORMANCE

## Round 1

### Test Panel Schematic for Round 1 Testing

CARC SB MIL-DTL-53039	(3)
CARC SB MIL-DTL-53039	(2)
CARC SB MIL-DTL-53039	(1)
Epoxy Primer SB MIL-P-53022B	(P)
Zinc Phosphated Steel	

CARC WB MIL-DTL-64159 Type II	(3)
CARC WB MIL-DTL-64159 Type II	(2)
CARC WB MIL-DTL-64159 Type II	(1)
Epoxy Primer WB MIL-P-53030	(P)
Zinc Phosphated Steel	

#### Sample Preparation:

#### Substrates:

- Cold Rolled steel Zinc Phosphated

#### Coating System:

Prepared according to ASTM-D6189-97:  
 “Standard Practice for Evaluating the Efficiency of Chemical Removers for Organic Coatings”

- Applied primer plus 3 layers of topcoat
- Alternated colors for easier stripping evaluation and ID



# IMMERSION PERFORMANCE

## Round 1

ROUND 1 IMMERSION TEST MATRIX		
Product	Phosphated Steel Substrate	
	SB CARC 53022B/53039	WB CARC 53030/64159
	Number of Panels	Number of Panels
RS75	2	2
Greensolv 273D	2	2
Greensolv 274WL	2	2
Ardrox 2865	2	2
Gardostrip Q7900	2	2
PR-5044	2	2
HT-2263	2	2
Al Strip 49 / AD 3030	2	2
CEM 483WW32	2	2
Al Strip 49	2	2
CEM 483WW23	2	2
Enviro Strip #3	2	2
Enviro Strip #1-S	2	2
Safety Strip 5896	2	2
Methylene Chloride/ H2O	2	2

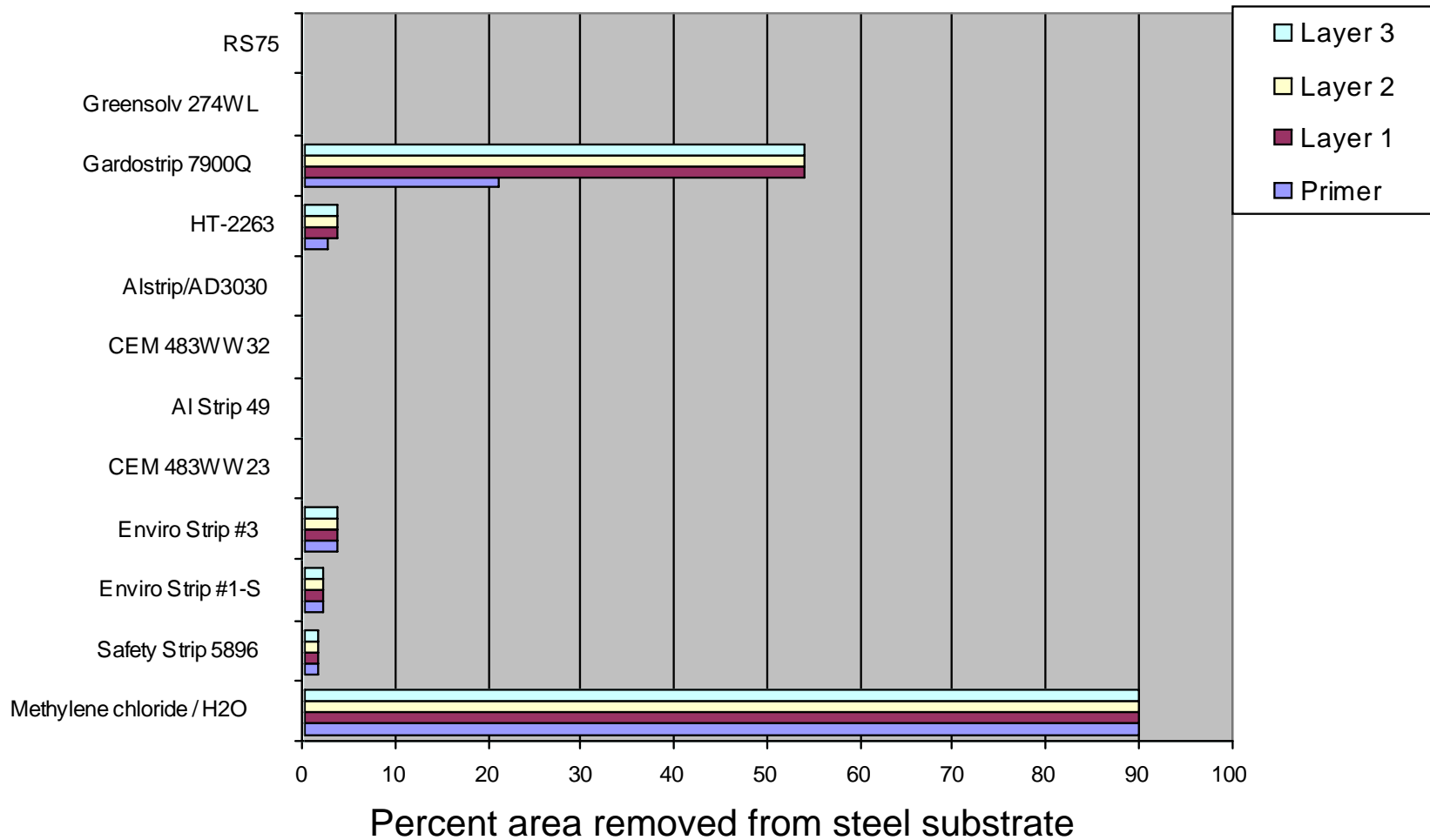




# IMMERSION PERFORMANCE

## Round 1

### Solvent-Borne MIL-DTL-53039 CARC System

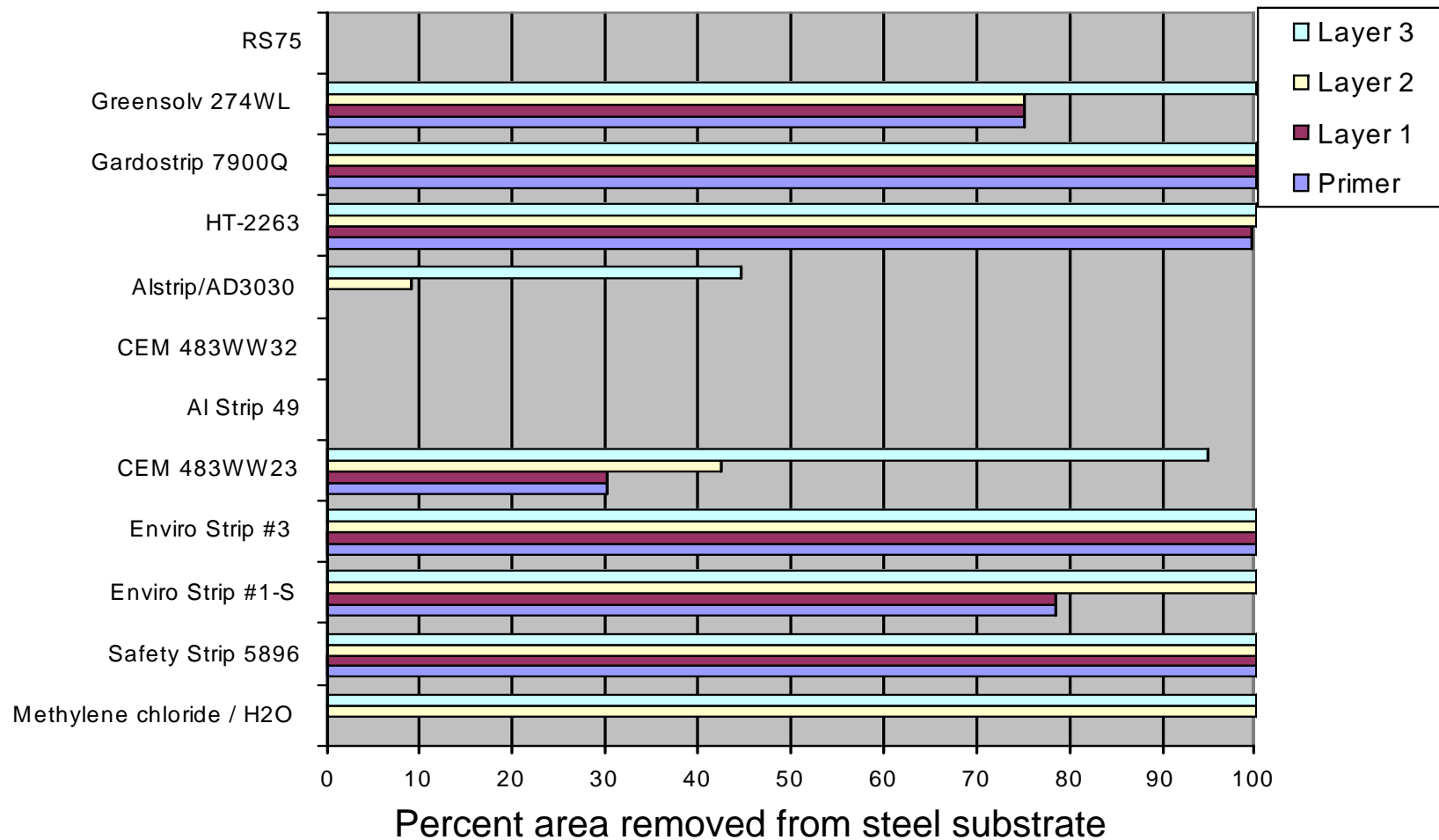




# IMMERSION PERFORMANCE

## Round 1

### Water-Borne MIL-DTL-64159 Type II CARC system



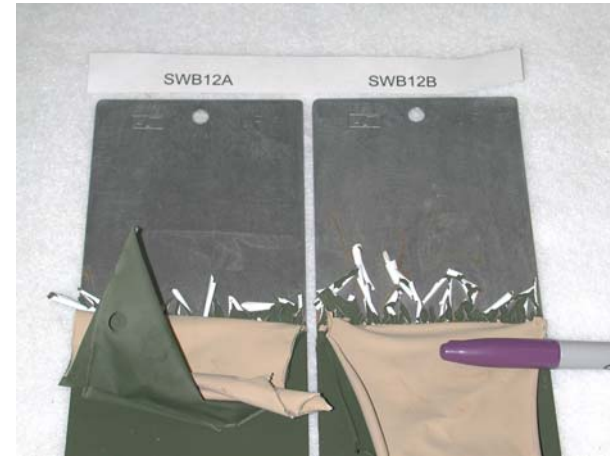


# IMMERSION PERFORMANCE

**Gardostrip  
Q7900**



Solvent-borne System  
53022B Primer / 53039 Topcoat



Water-borne System  
53030 Primer / 64159 Topcoat

**Straight  
Methylene  
Chloride**



Solvent-borne System  
53022B Primer / 53039 Topcoat



Water-borne System  
53030 Primer / 64159 Topcoat



# IMMERSION PERFORMANCE

## Round 2

ROUND 2 IMMERSION TEST MATRIX				
Product	Phosphated Steel Substrate (S)		Chromated Al Substrate (A)	
	(SB) 53022B/46168	(WB) 53030/64159	(SB) 53022B/46168	(WB) 53030/64159
<b>K-Chem III</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
Greensolv 274WL	2	2	2	2
<b>Dip Strip</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
<b>D-Zolve 298</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
<b>D-Zolve 15-33LO</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
Safety Strip 5896	2	2	2	2
Enviro Strip #3	2	2	2	2
HT-2263	2	2	2	2
Gardostrip Q7900	2	2	2	2
<b>NPX</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>



# IMMERSION PERFORMANCE

## Round 2

### Test Panel Schematic for Round 2 Testing

CARC SB MIL-C-46168	(3)
CARC SB MIL-C-46168	(2)
CARC SB MIL-C-46168	(1)
Epoxy Primer SB MIL-P-53022B	(P)
Chromated Aluminum or Zinc Phosphated Steel	

CARC WB MIL-DTL-64159 Type I	(3)
CARC WB MIL-DTL-64159 Type I	(2)
CARC WB MIL-DTL-64159 Type I	(1)
Epoxy Primer WB MIL-P-53030	(P)
Chromated Aluminum or Zinc Phosphated Steel	

*Also evaluated new products against MIL-DTL-53039*

#### Sample Preparation:

#### Substrates:

- Alodine Chromate pretreated 2024 aluminum
- Zinc Phosphated cold rolled steel

#### Coating System:

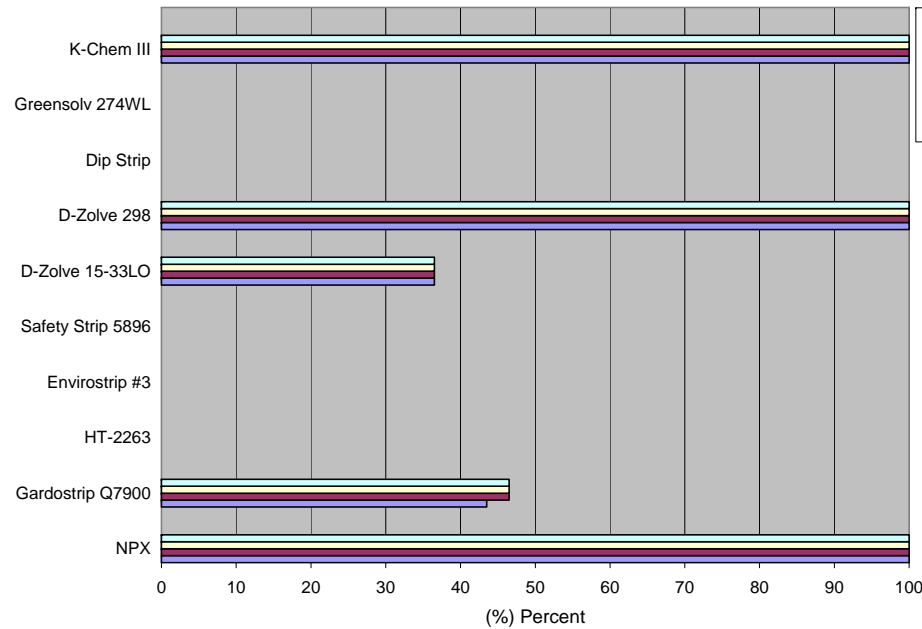
#### Prepared according to ASTM-D6189-97:

- Applied primer plus 3 layers of topcoat
- Alternated colors for easier stripping evaluation and ID

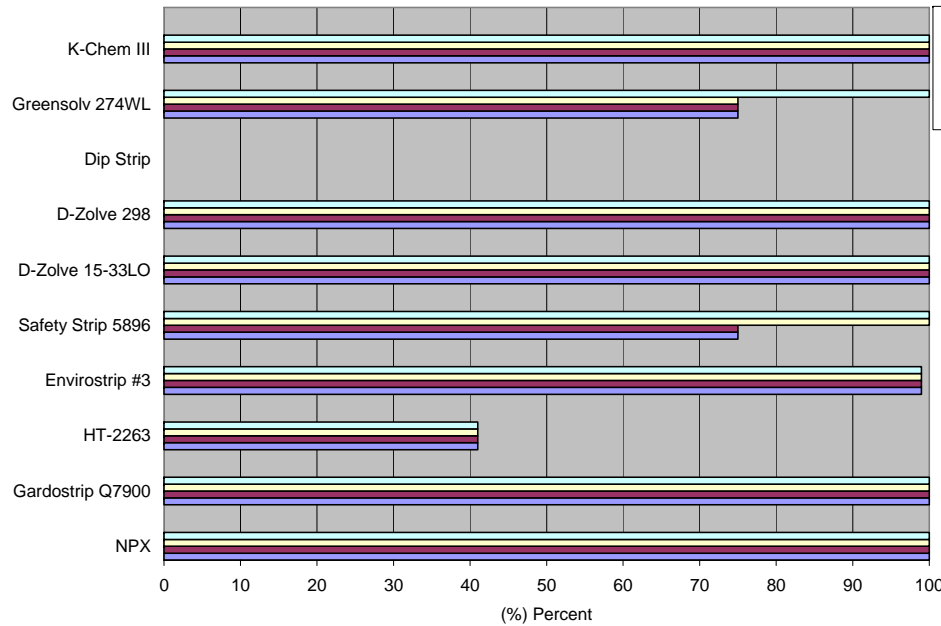


# IMMERSION PERFORMANCE

Round 2  
Steel Substrate



MIL-DTL-64159  
Type I CARC

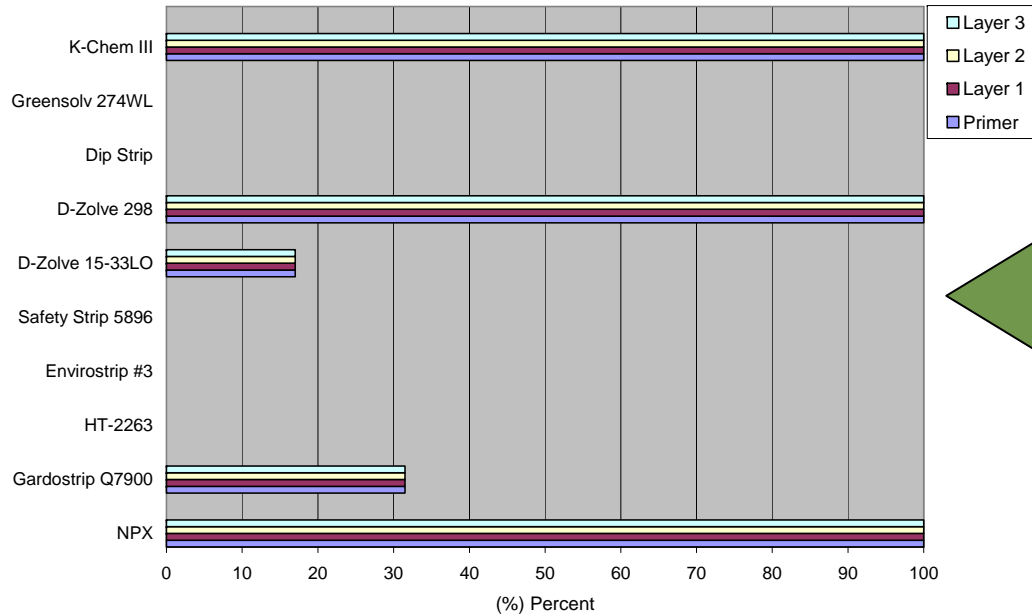


MIL-C-46168  
Type I CARC

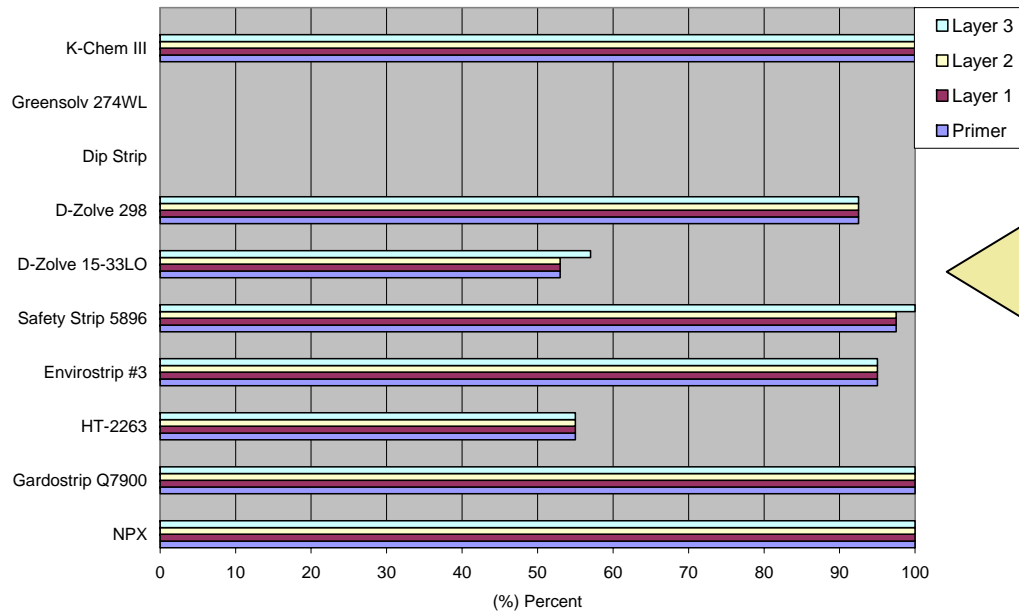


# IMMERSION PERFORMANCE

## Round 2 Aluminum Substrate



MIL-DTL-64159  
Type I CARC



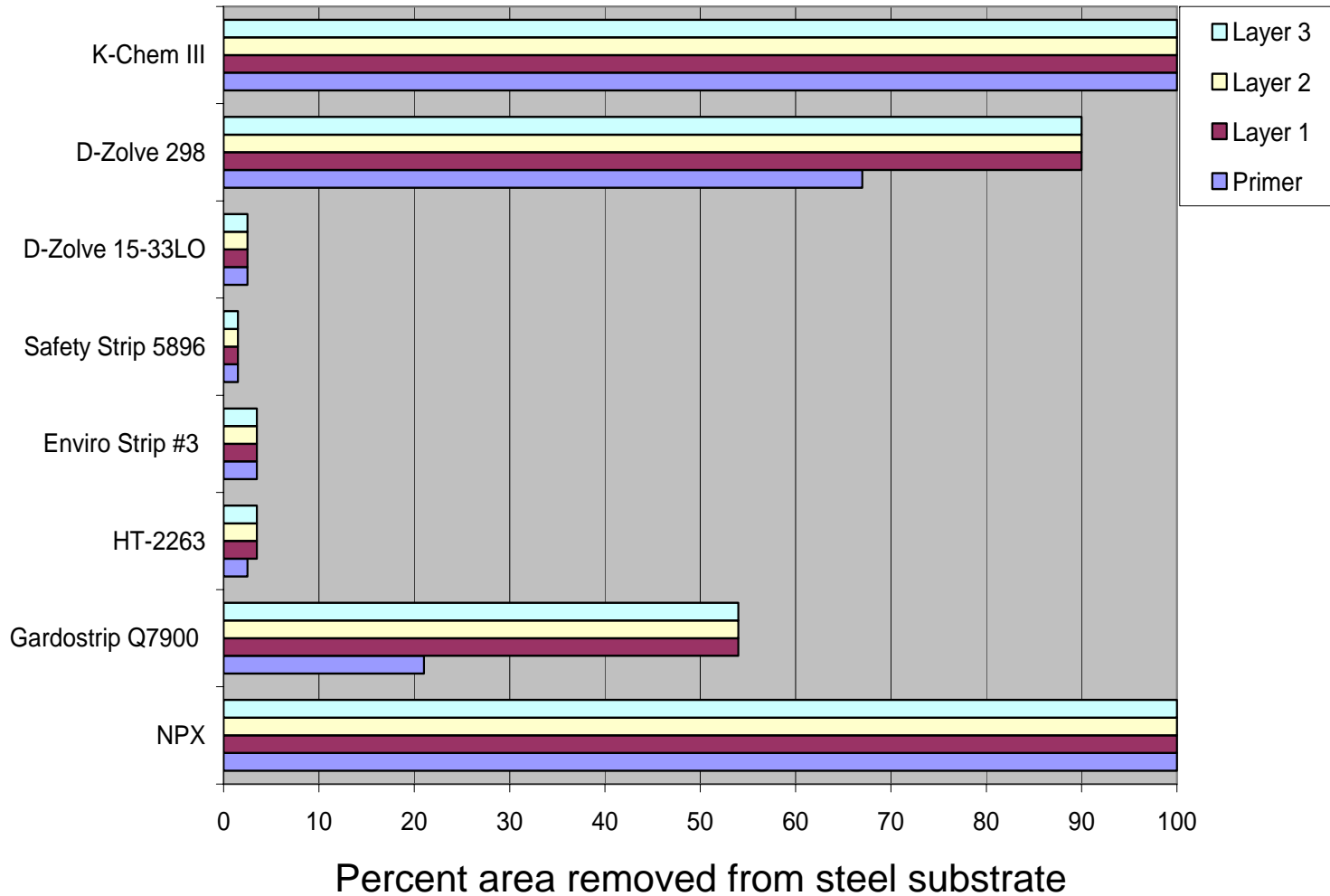
MIL-C-46168  
Type I CARC



# IMMERSION PERFORMANCE

## Round 2

### Solvent-Borne MIL-DTL-53039 CARC System

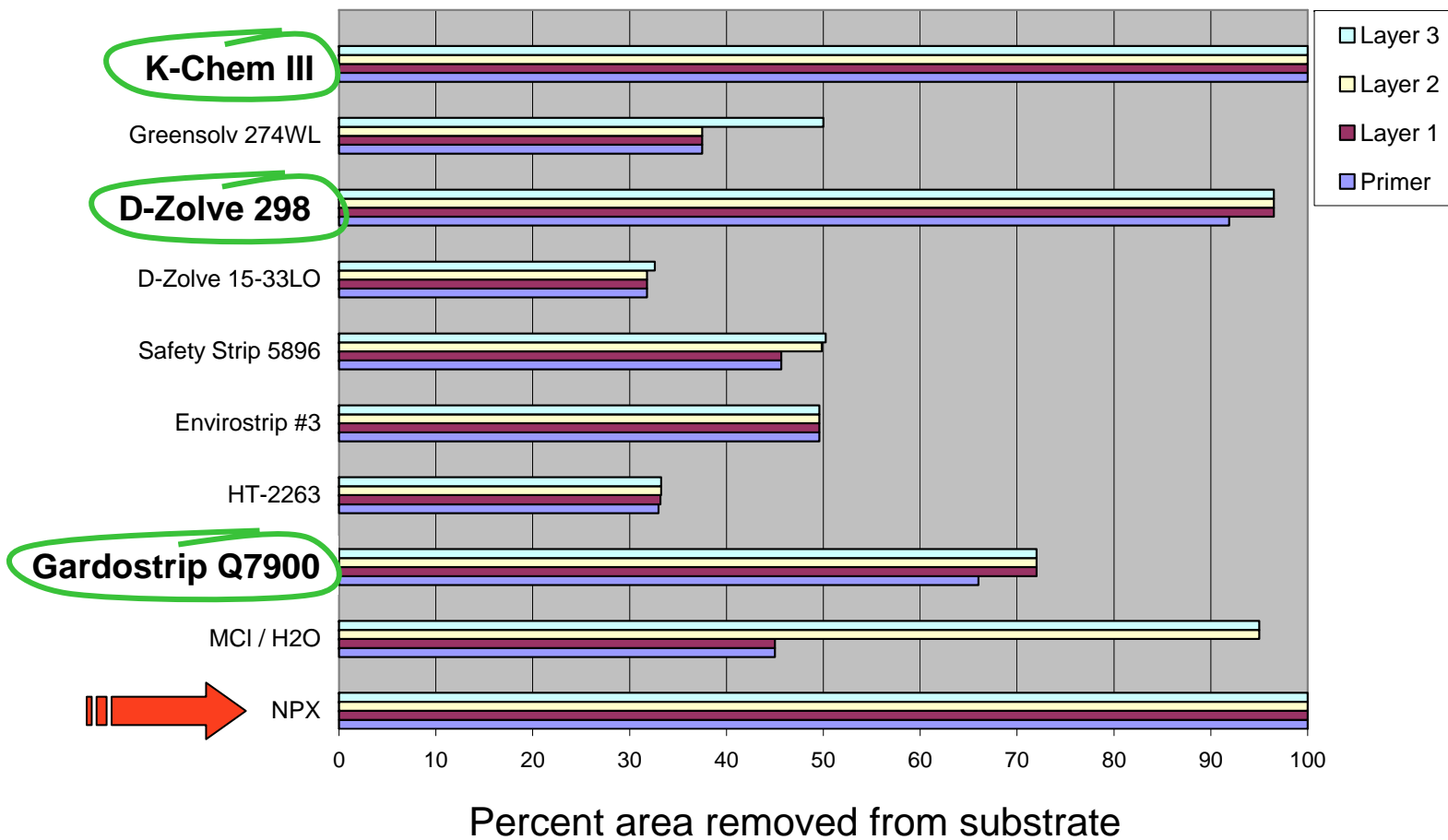






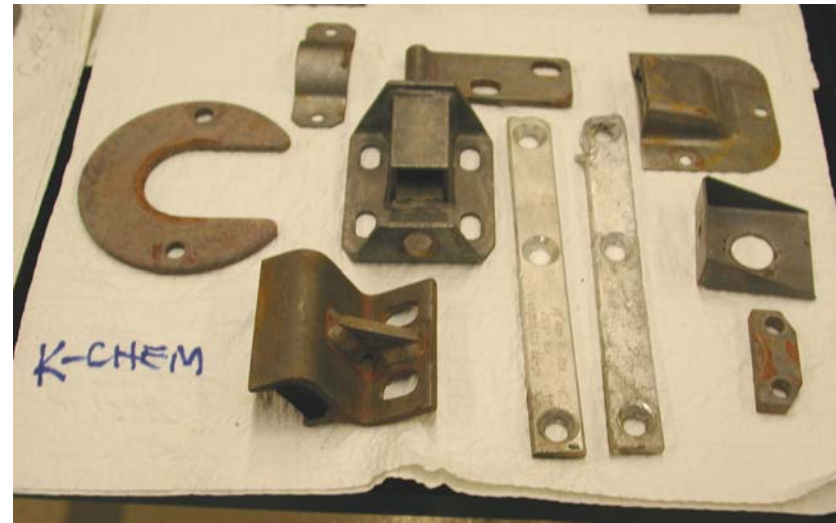
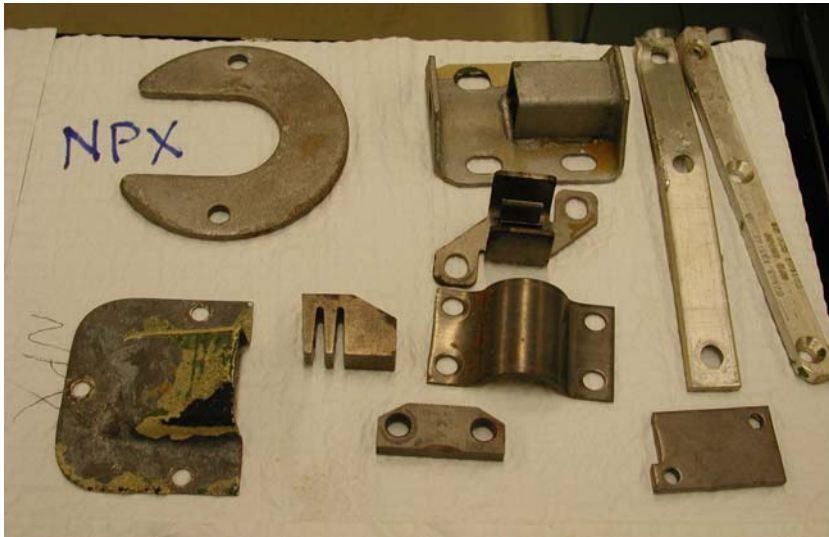
# IMMERSION PERFORMANCE Composite Chart

Overall immersion stripping performance averaged across all CARC versions regardless of substrate





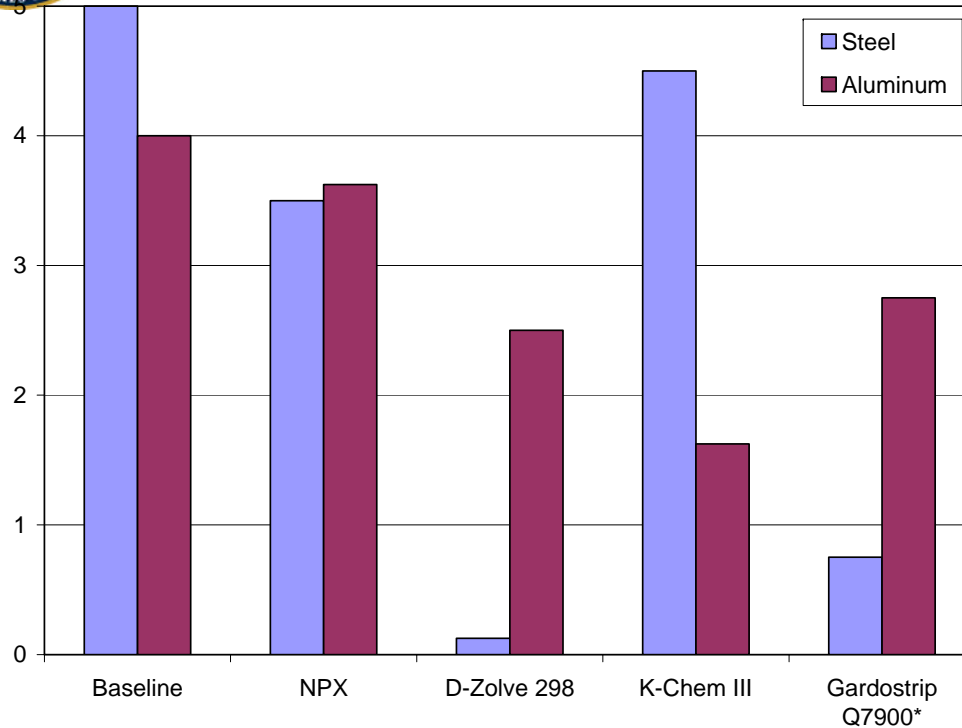
# IMMERSION PERFORMANCE Component Tests



*Cleared for Public Release*



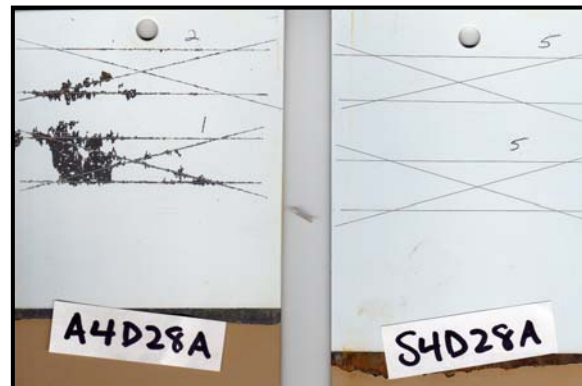
# REPAINTABILITY



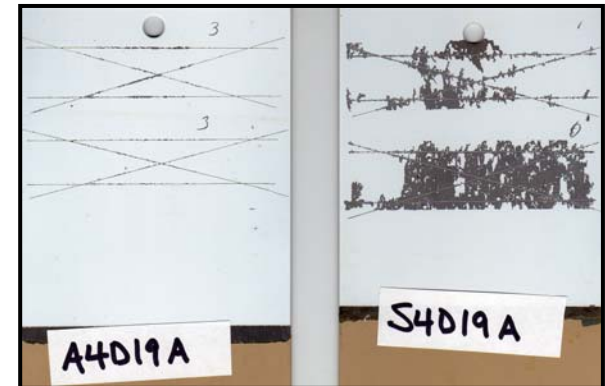
1. Stripped surface rinsed with DI water
2. Wiped with MEK
3. Repainted with epoxy primer and cured 1 week
4. Wet Adhesion test performed per ASTM-D 3359
5. Results compared to new identically painted panel (baseline)



D Zolve 298



K-Chem III



Gardostrip

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# IPT MEETING

December 13, 2005



## ANAD MEMBERS

Jack Kelley--ARL; Matthew Teliarferro--PED; Simon Barsoum--DP; Nanda Mukherjee--DP; Donald O'Shaughnessy--DP; Dave Kane--Safety; John Larkins--DRR-C; Heather Bowman; Matt Miller; Steve Henry--IH; Joseph Doyle--Legal

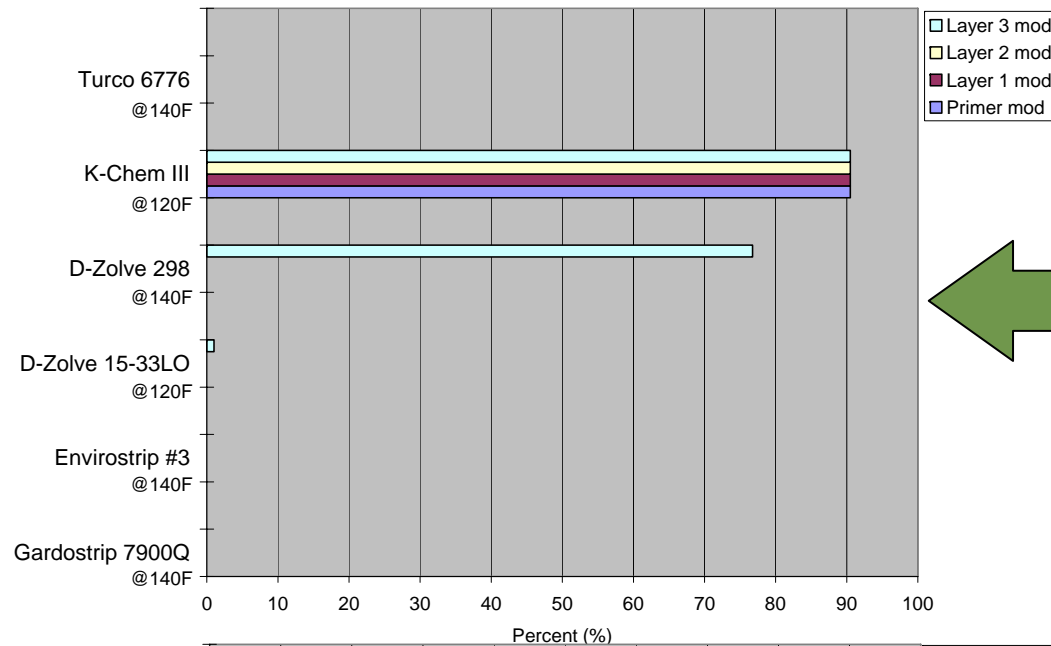
## KEY POINTS:

- ❖ Inconsistent repaintability results not a concern for ANAD
- ❖ Strippers cannot be heated to within 50°F of the product flash point without added controls
- ❖ ANAD will consider relaxing strip time requirements for immersion from 30 min to 60 min

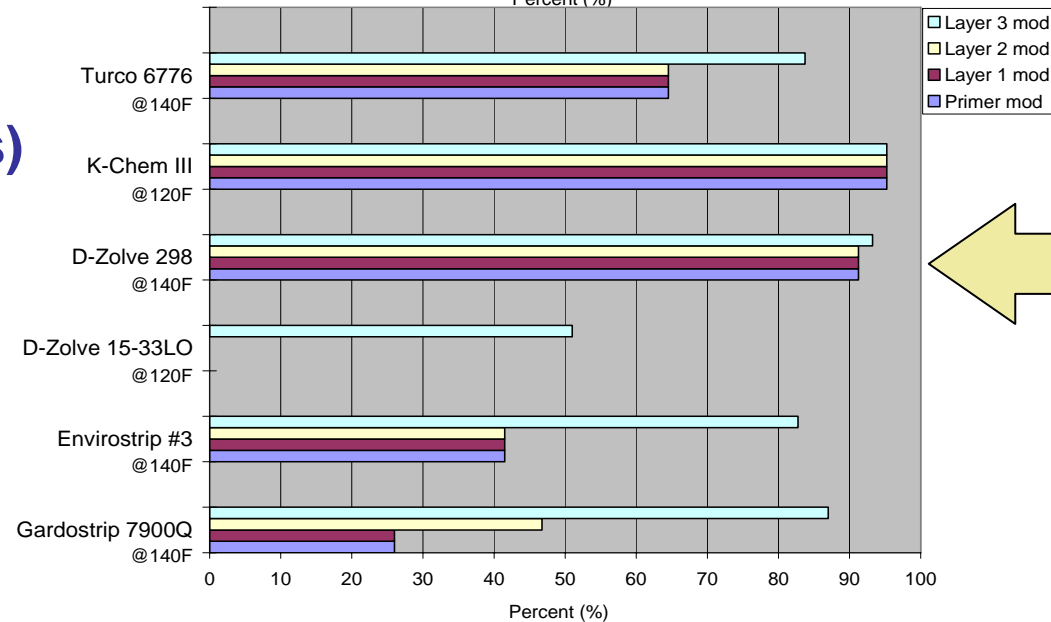


# IMMERSION PERFORMANCE

**Performance  
@ 50F Below  
Product  
Flashpoint  
(30 min immers)**



**MIL-DTL-64159  
Type I CARC**

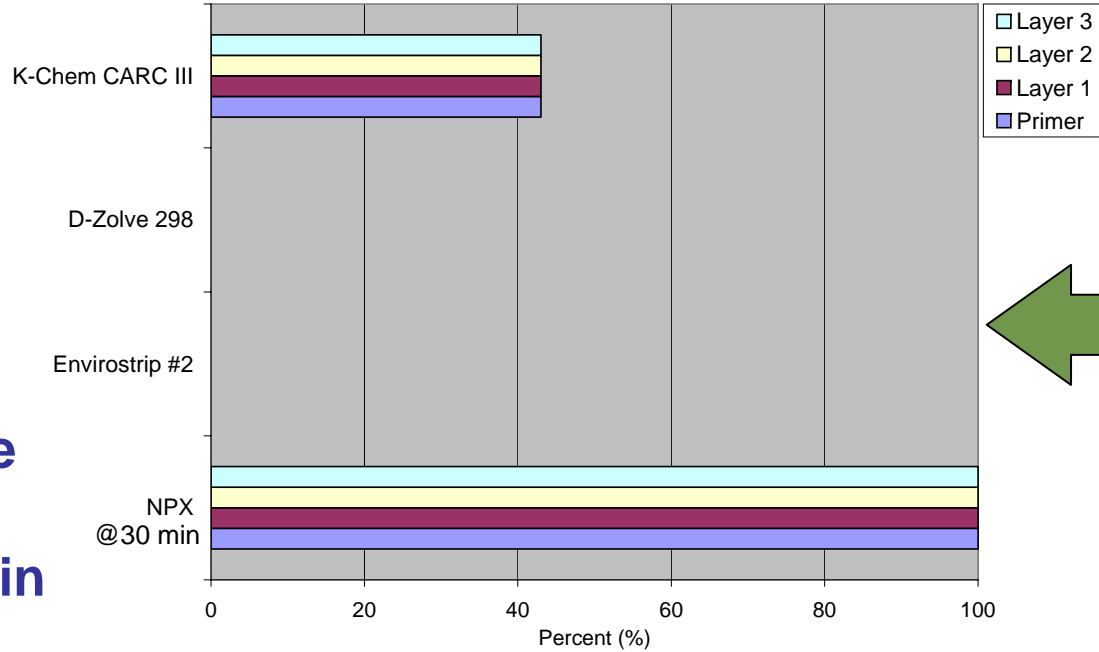


**MIL-C-46168  
Type I CARC**

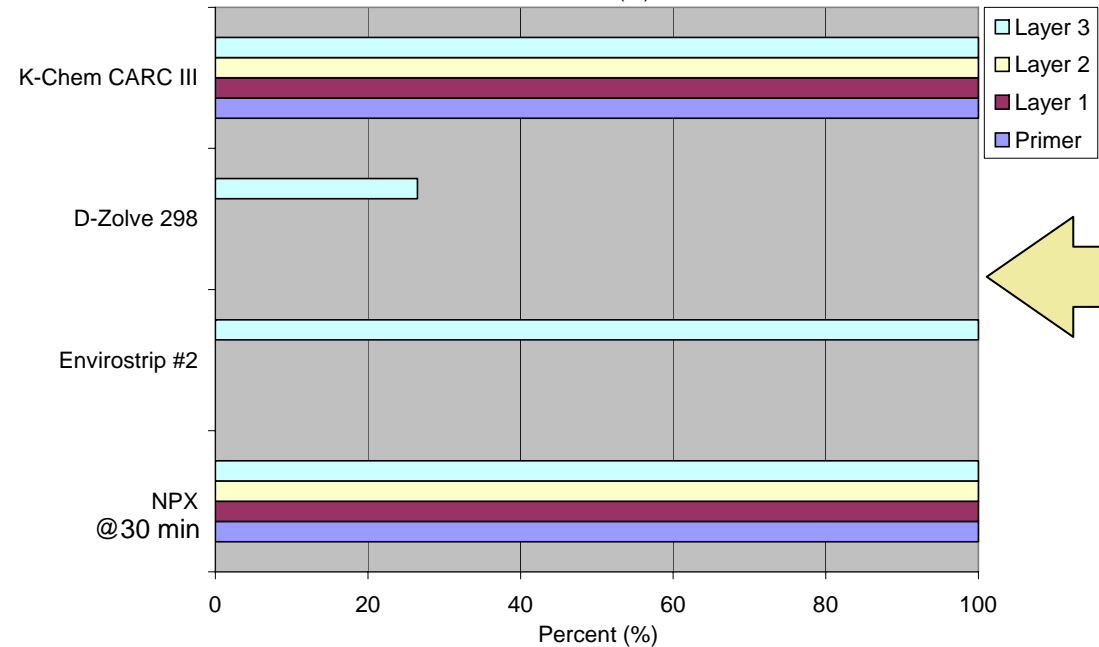


# IMMERSION PERFORMANCE

Stripping  
Performance  
@ Ambient  
Temperature in  
60 minute  
immersion



MIL-DTL-64159  
Type I CARC



MIL-C-46168  
Type I CARC



# CONCLUSIONS

- Based on stripping performance alone DZolve 298 and K-Chem CARC Stripper III, when heated, can be viable alternatives to methylene chloride strippers if a 30 minute strip time is required.
  - CAVEAT: These strippers with pH of 2 should be used cautiously on materials known to be susceptible to hydrogen embrittlement
- When heated, several of the HAP-free strippers were nearly as effective at removing Solvent borne MIL-C-46168 as the methylene chloride based
- The success of many of the HAP free strippers on the water-borne MIL-DTL-64159 **type II** suggests that a broader use of this CARC version, in the long run, will:
  - ✓ Help maintain shorter strip times
  - ✓ Enable DOA to remain in compliance with the NESHAP regulations
  - ✓ Provide a wider selection of the HAP free strippers available.
- Inconsistent repaintability results indicate pretreatments may have been effected
- One candidate, K-Chem CARC Stripper III, can be effective at room temperature if immersion time is increased to 60 minutes.