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

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OUTLINE

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

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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

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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

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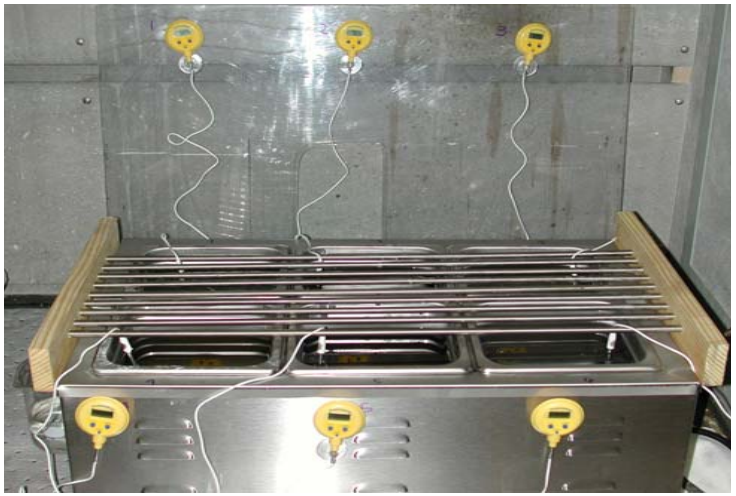
EXPERIMENTAL PROCEDURE

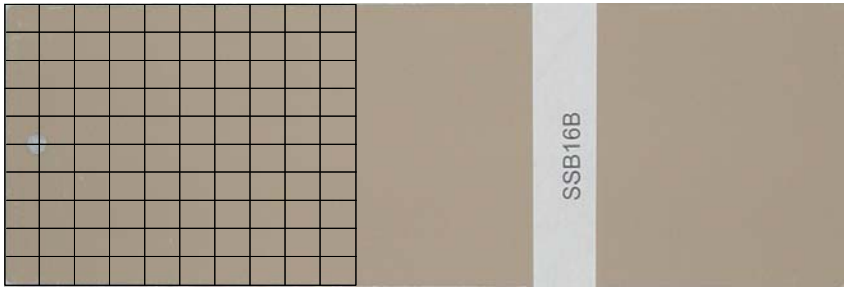
Immersion Tests:

- HAP-free products were heated to between 150^{o} -170^{o} 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**



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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	

<u>Sample Preparation:</u>

Substrates:

- Cold Rolled steel Zinc Phosphated

<u>Coating System:</u>

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

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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

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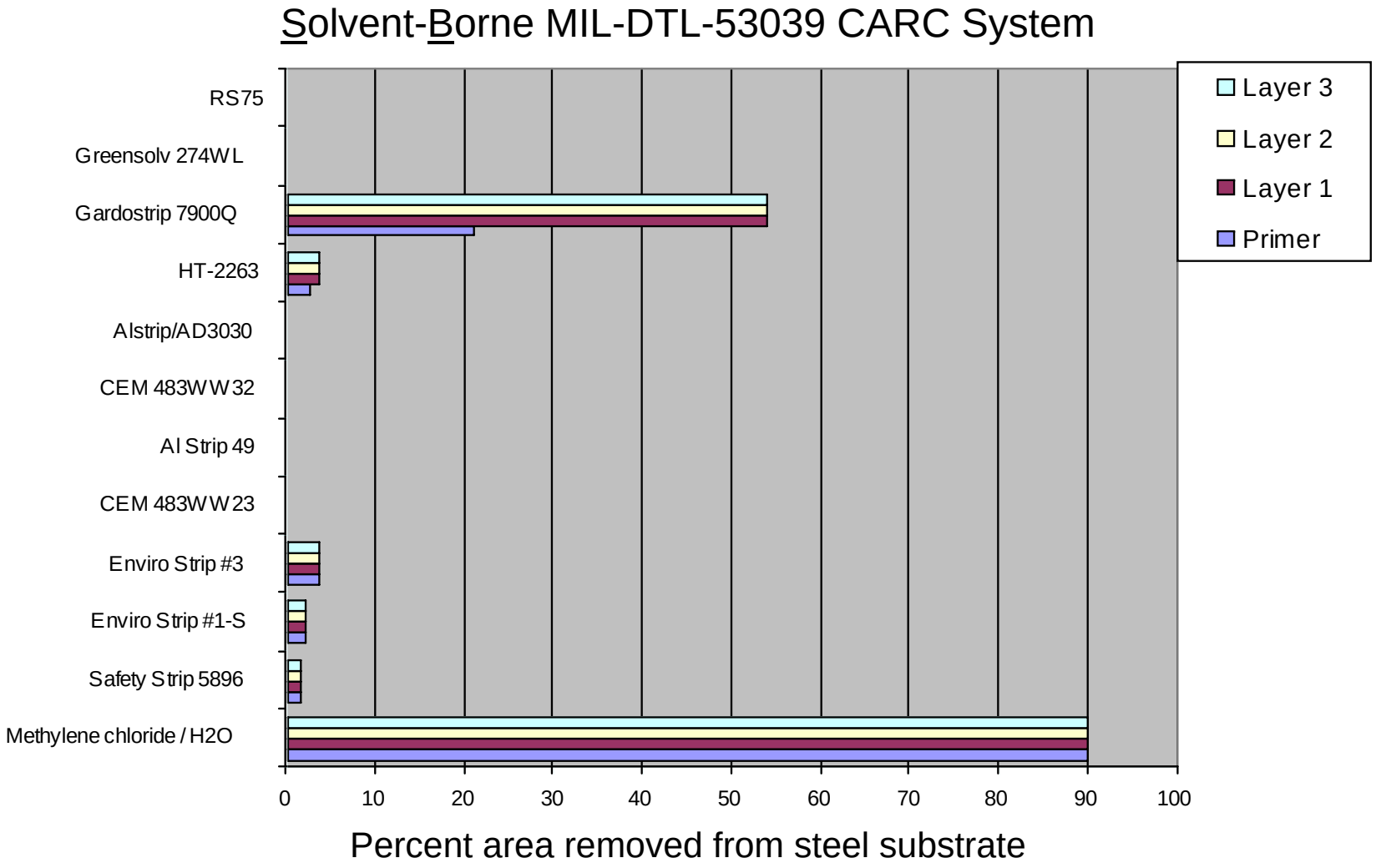
IMMERSION PERFORMANCE

Round 1



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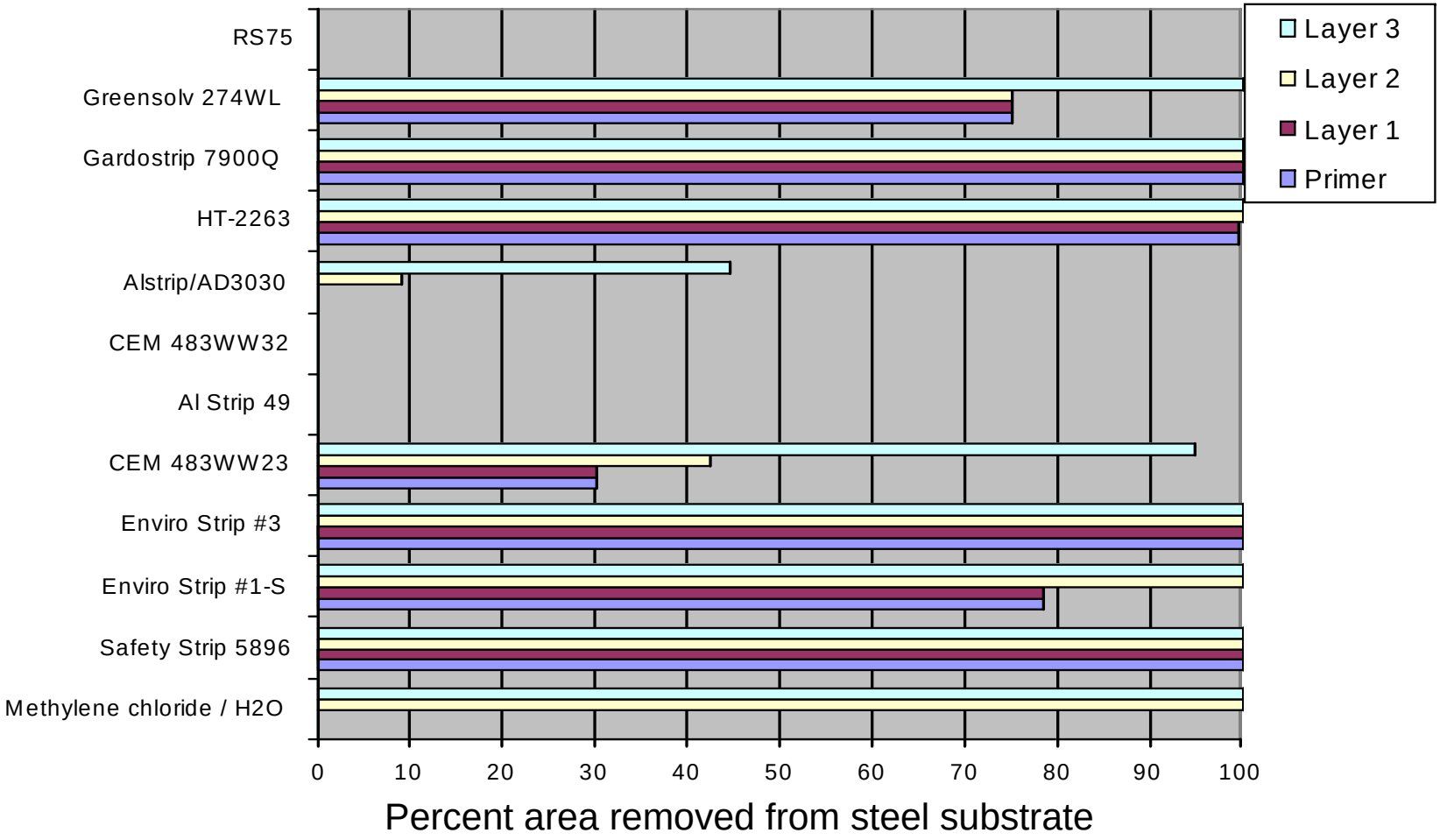
IMMERSION PERFORMANCE

Round 1

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



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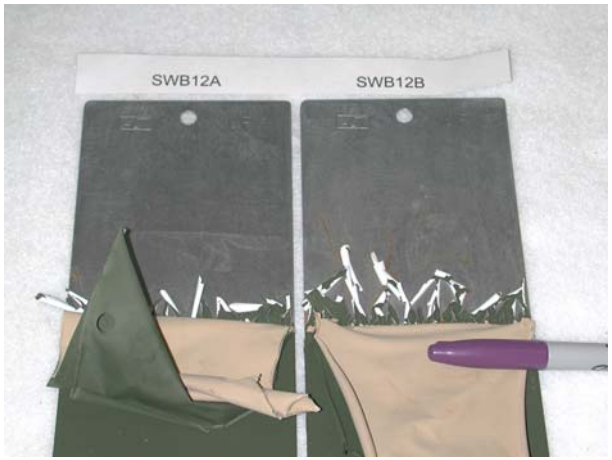
IMMERSION PERFORMANCE

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

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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
K-Chem III	**2**	**2**	**2**	**2**
Greensolv 274WL	2	2	2	2
Dip Strip	**2**	**2**	**2**	**2**
D-Zolve 298	**2**	**2**	**2**	**2**
D-Zolve 15-33LO	**2**	**2**	**2**	**2**
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
NPX	***2***	***2***	***2***	***2***

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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 <u>new</u> products against MIL-DTL-53039

<u>Sample Preparation:</u>

Substrates:

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

<u>Coating System:</u>

Prepared according to ASTM-D6189-97:

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

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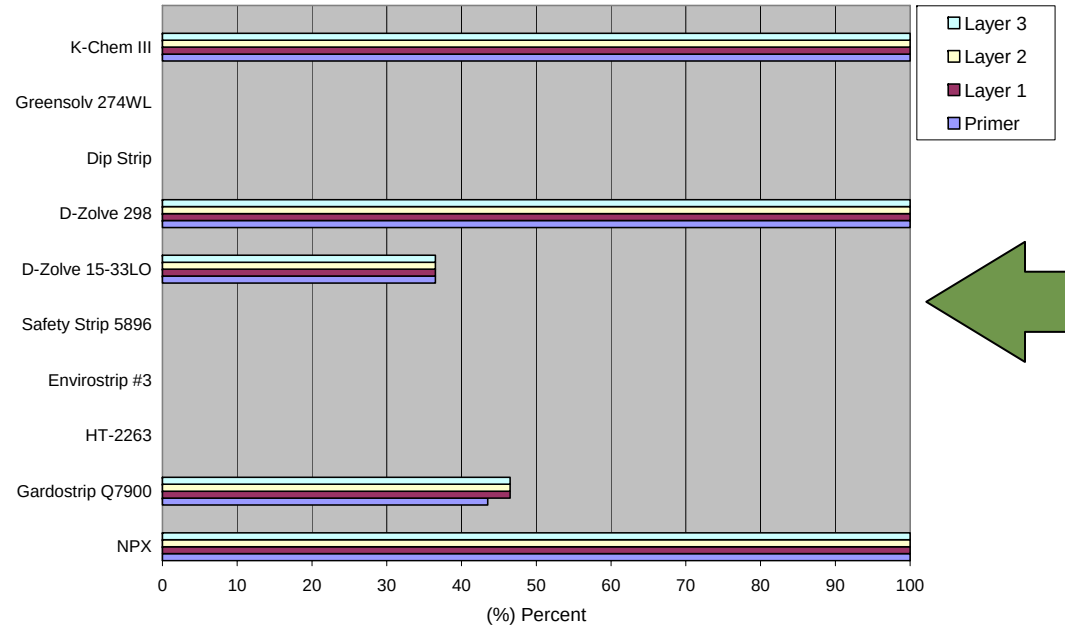
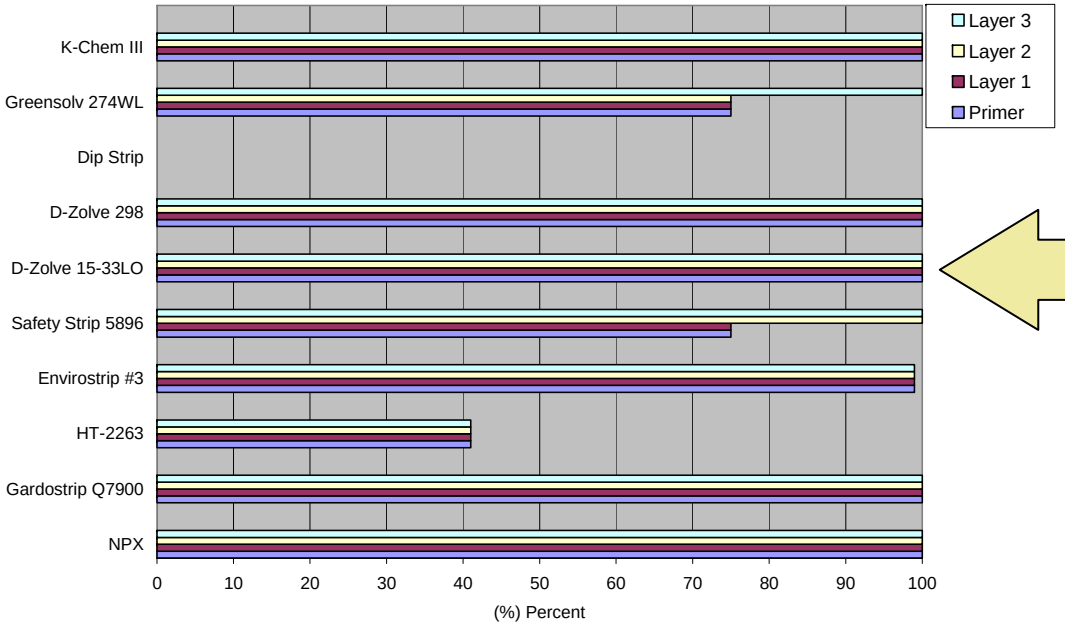
IMMERSION PERFORMANCE

Round 2
Steel Substrate



MIL-DTL-64159
Type I CARC



MIL-C-46168
Type I CARC

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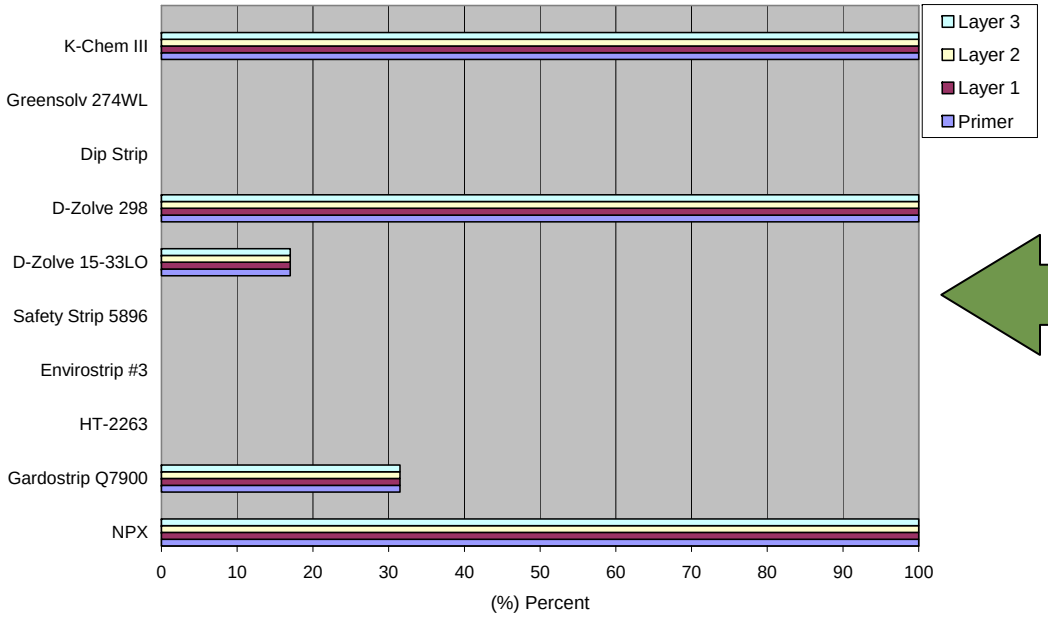
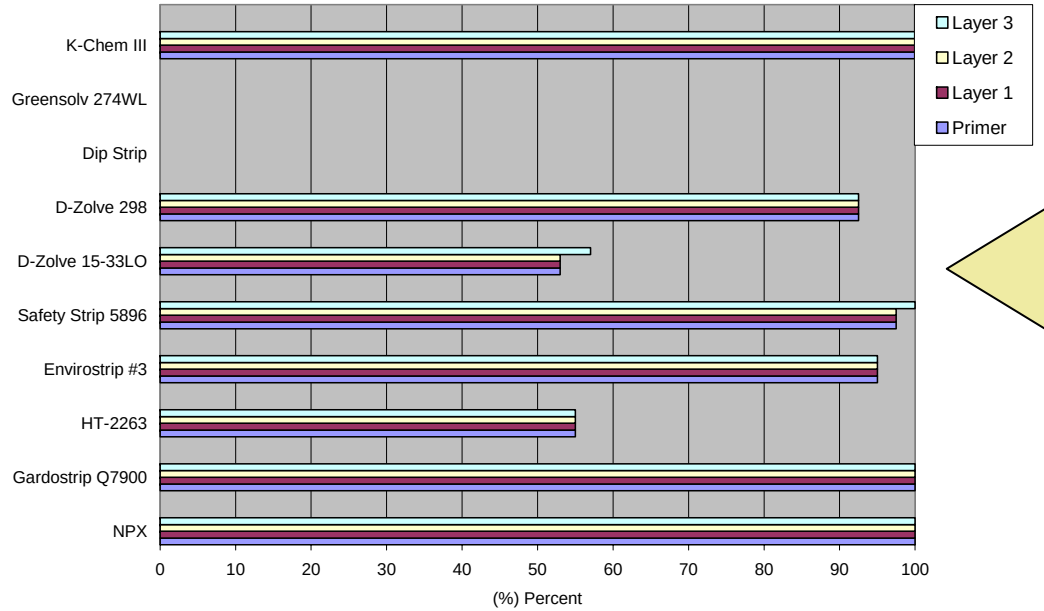
IMMERSION PERFORMANCE

Round 2
Aluminum Substrate



MIL-DTL-64159
Type I CARC



MIL-C-46168
Type I CARC

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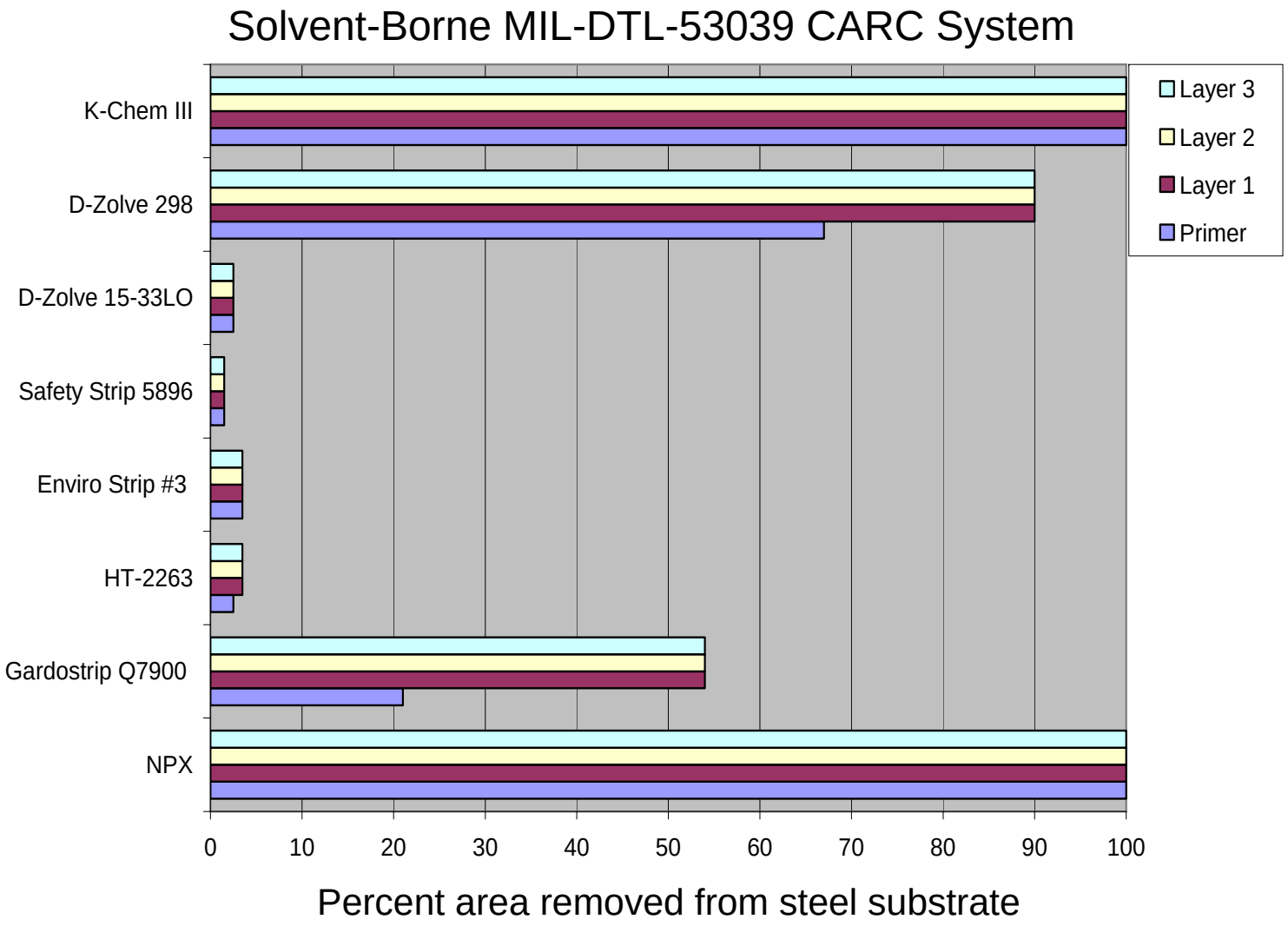
IMMERSION PERFORMANCE
Round 2



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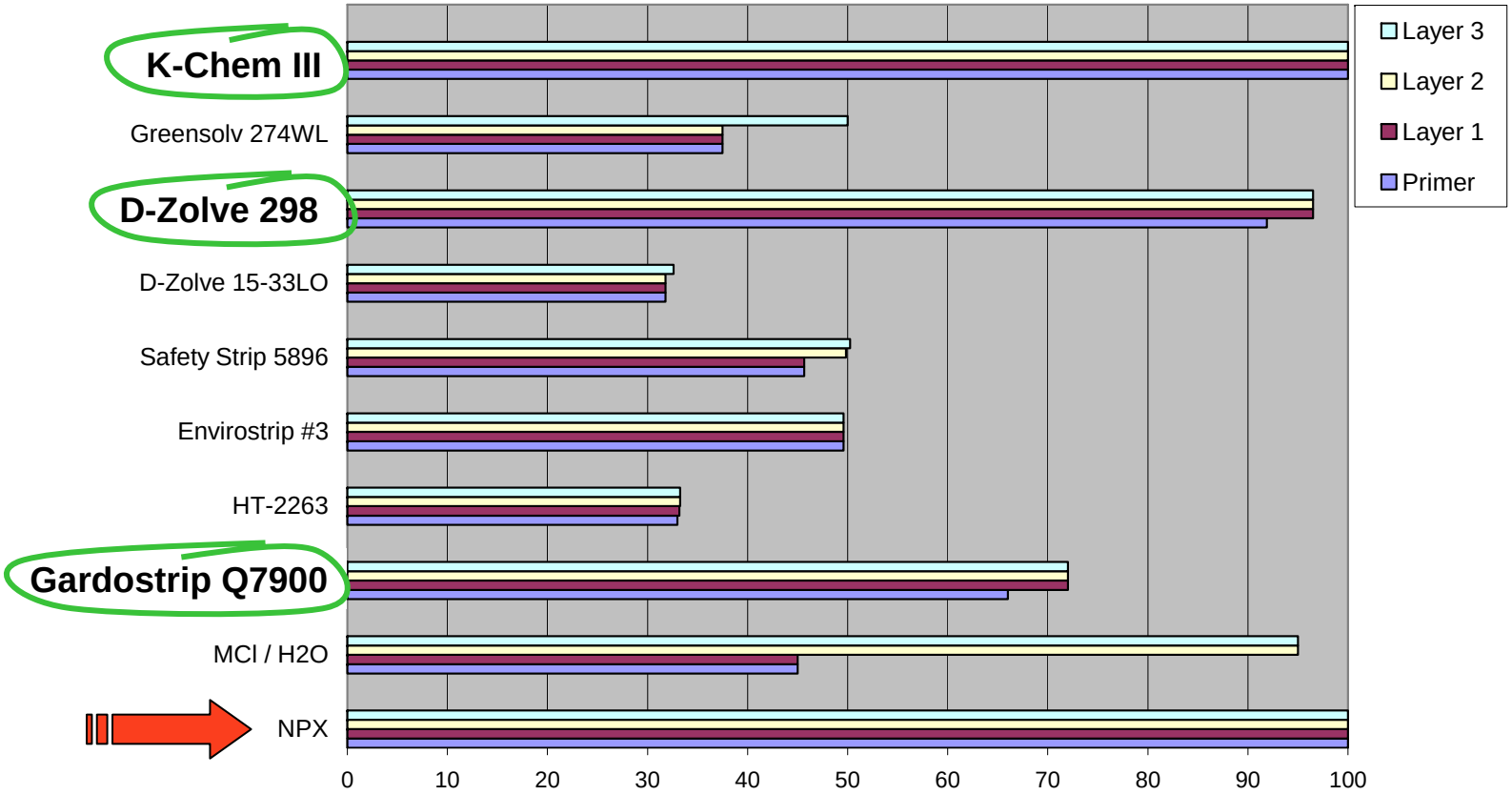
IMMERSION PERFORMANCE

Composite Chart

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



Percent area removed from substrate

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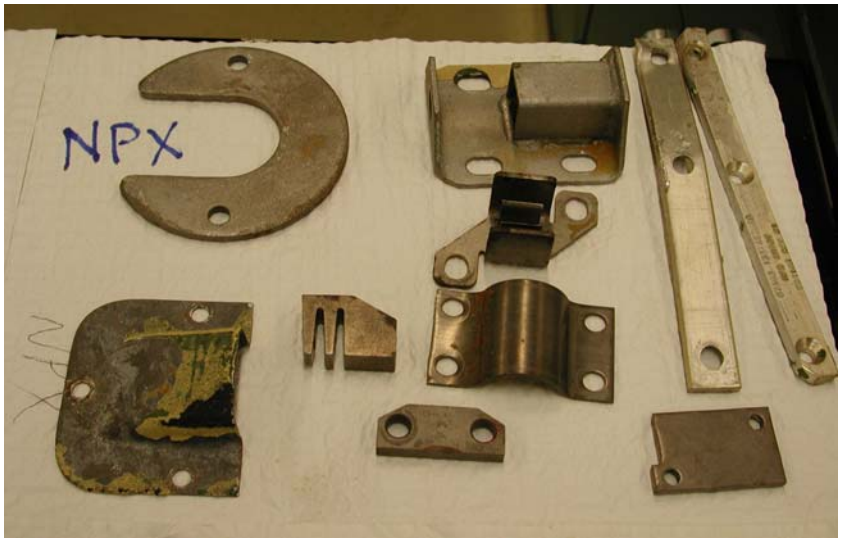
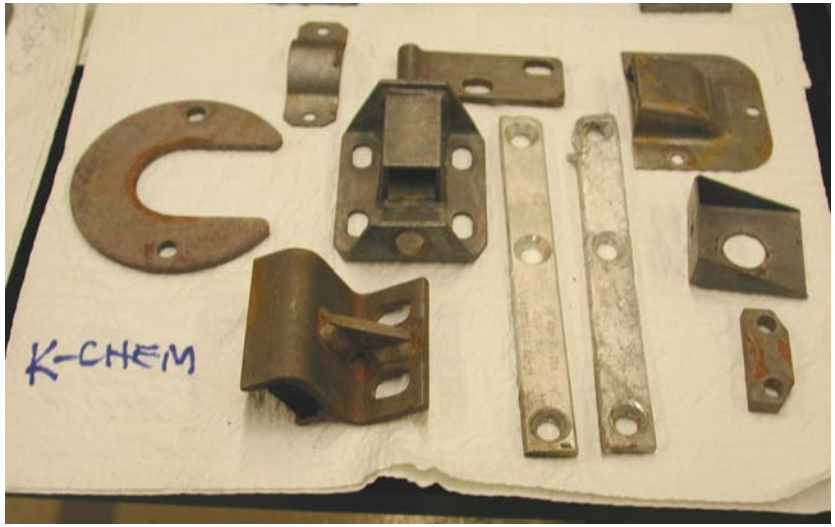
IMMERSION PERFORMANCE

Component Tests





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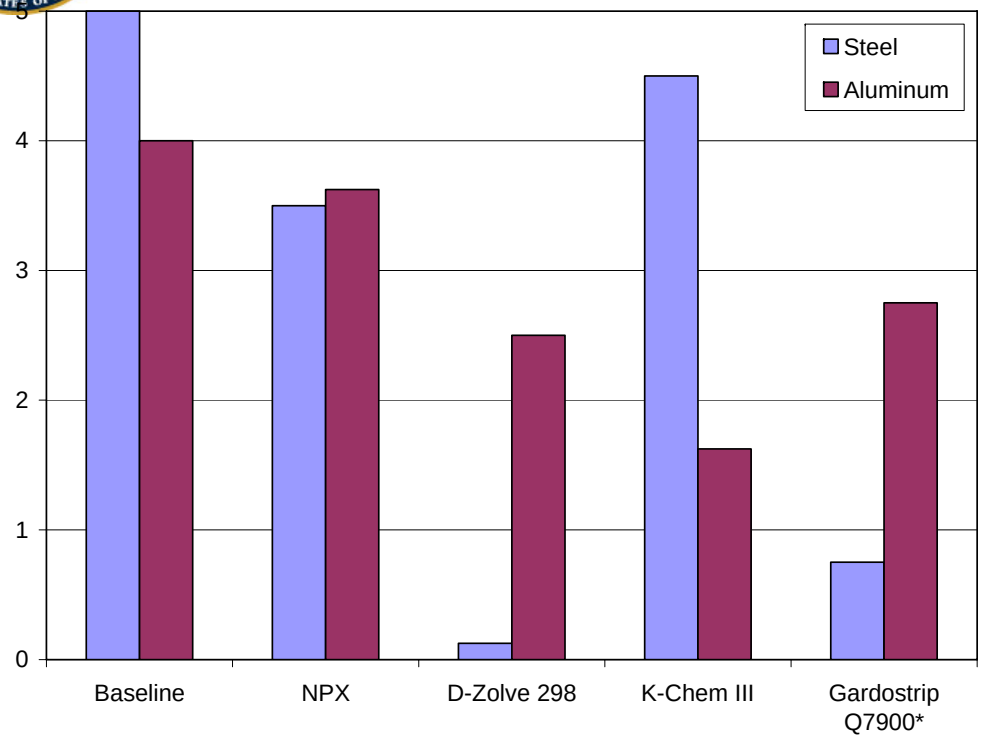
REPAINTABILITY



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 Teliaferro--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^{o}F of the product flash point without added controls
- ❖ ANAD will consider relaxing strip time requirements for immersion from 30 min to 60 min

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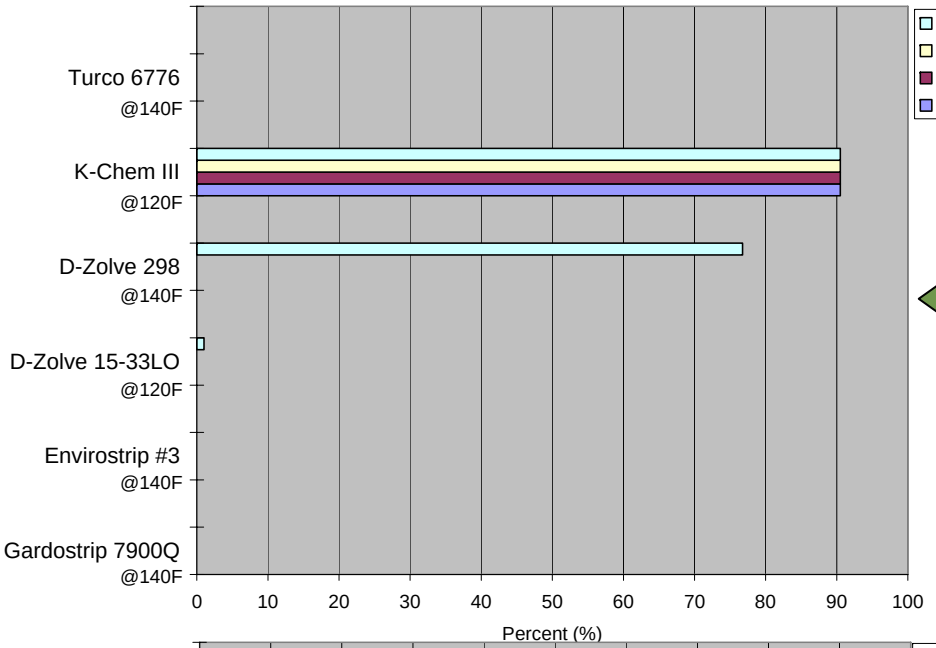
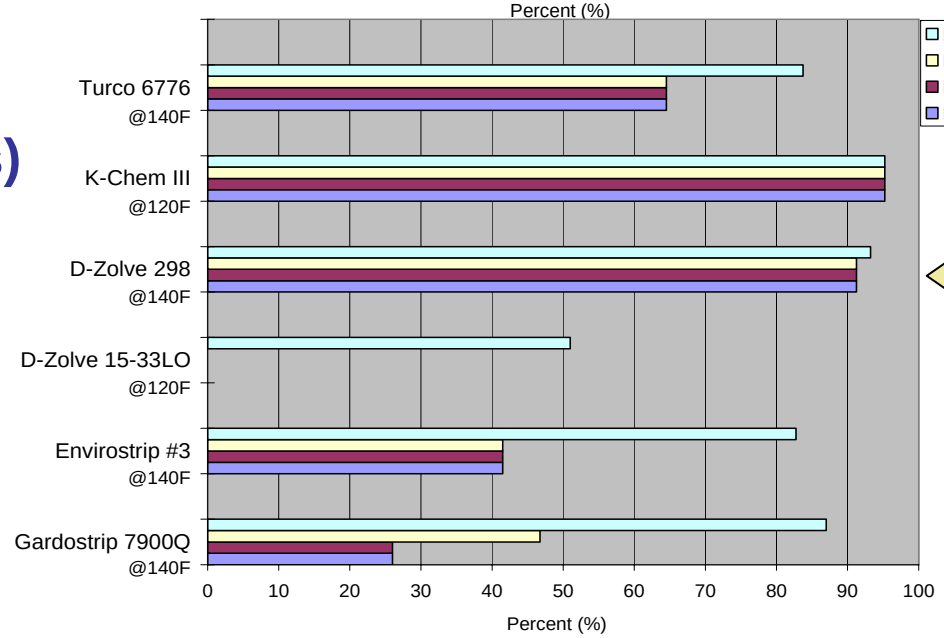
IMMERSION PERFORMANCE

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



MIL-DTL-64159 Type I CARC



MIL-C-46168 Type I CARC

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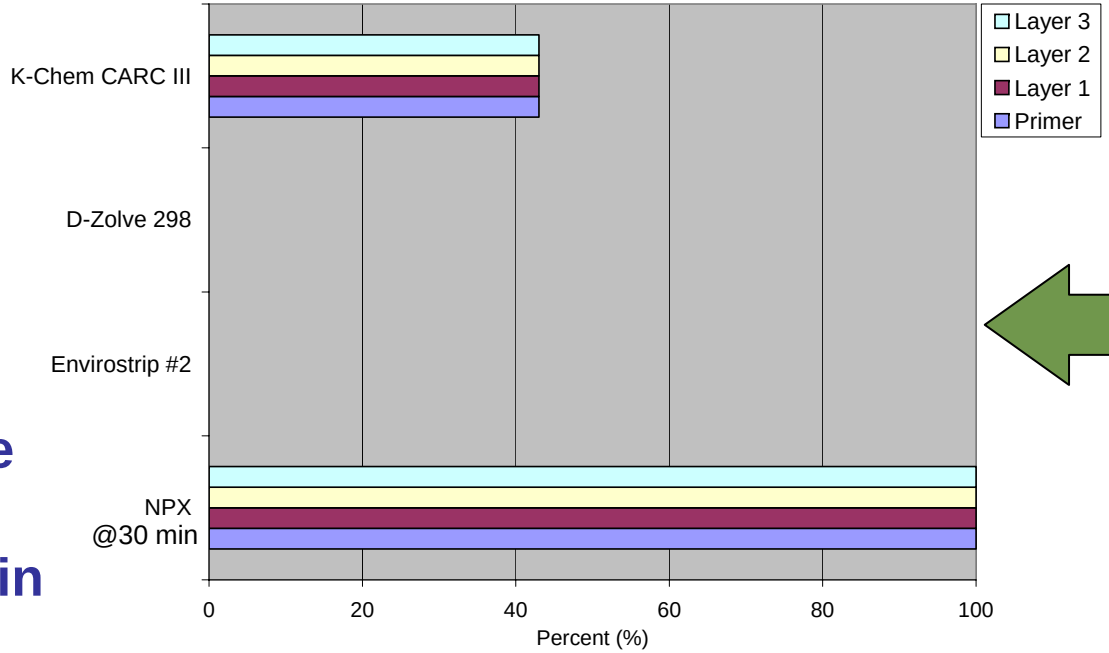
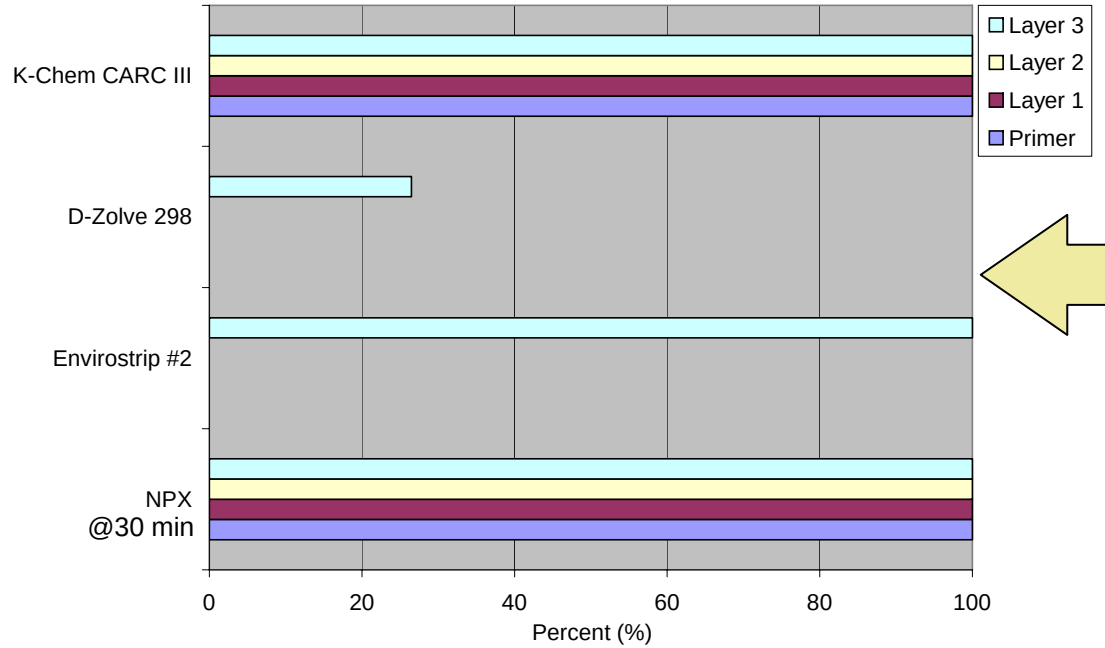
IMMERSION PERFORMANCE

Stripping Performance @ Ambient Temperature in 60 minute immersion



MIL-DTL-64159 Type I CARC



MIL-C-46168 Type I CARC

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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.

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