

1/1

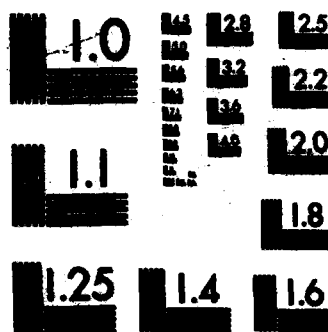
S B LEVINSON ET AL. 30 JUL 82 DL-6010 DAAK70-81-C-0100

F/G 15/2

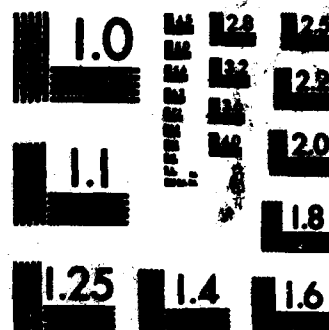
NL

UNCLASSIFIED

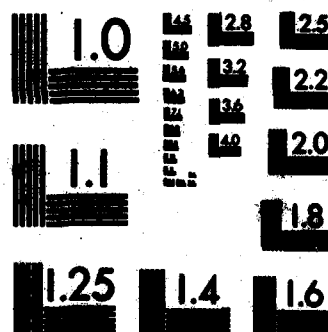
[illegible]



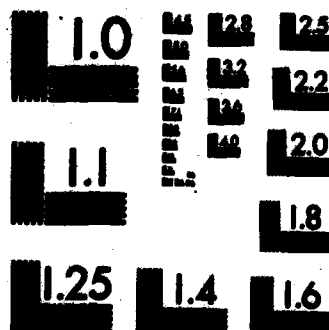
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



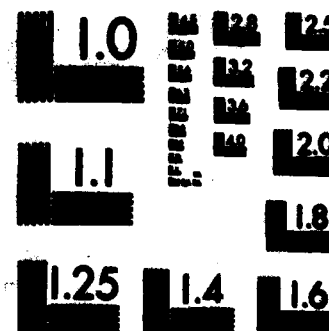
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



(12)

(ESTABLISHED 1952)

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410 TWX: 710-581-6132

ADA 120833

DL-6010

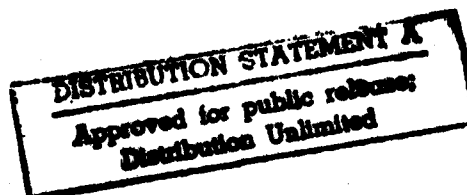
EVALUATION OF
WATER-BORNE
LEAD AND CHROMIUM FREE
ANTI-CORROSIVE PRIMERS

Contract No. DAAK70-81-0100

Prepared for US ARMY MERADCOM

DTIC FILE COPY

July 30, 1982



Jerry H. Willner
Jerry H. Willner
Chief Chemist

Saul Spindel
Saul Spindel
Technical Director

Sidney B. Levinson
Sidney B. Levinson
President

82 10 14 037

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DAAK70-81-0100	2. GOVT ACCESSION NO. AD-A120833	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Evaluation of Water-Borne Lead and Chromium Free Anti-Corrosive Primers		5. TYPE OF REPORT & PERIOD COVERED Final 26 Jun 1981 to 30 Jul 1982
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Sidney B. Levinson Saul Spindel Jerry H. Willner		8. CONTRACT OR GRANT NUMBER(s) DAAK70-81-0100
9. PERFORMING ORGANIZATION NAME AND ADDRESS D/L Laboratories 116 East 16th Street New York, N.Y. 10003		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AK11/E34/81
11. CONTROLLING OFFICE NAME AND ADDRESS US Army MERADCOM Ft. Belvoir, VA 22060		12. REPORT DATE July 30, 1982
		13. NUMBER OF PAGES 76
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Reproduction of this report in whole or in part is permitted for any purpose of the United States Government.		
DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
Air quality regulation	Lead	Survey
Aluminum	Primer	VOC
Chromium VI	Proprietary	Water-borne
Corrosion resistance	Steel	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) US AMERADCOM is striving to replace primers used on Army Equipment with low VOC coatings in order to meet air quality regulations and to eliminate lead and Chromium VI. 35 water-borne, lead and chromium-free formulations and proprietary primers were evaluated. One formulation and one proprietary primer are almost equal to IT-P-1757 in corrosion resistance. Another formulation and two proprietary primers are acceptable with minor modifications. Six other formulations and one proprietary primer are acceptable for use on aluminum but not on steel.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FOREWARD

US AMERADCOM is striving to replace the metal primers presently used on Army equipment in order to meet present or anticipated air regulations issued to reduce air pollution from volatile organic compounds, and to eliminate toxic corrosion-inhibiting pigments. Therefore, this program was instituted to locate and evaluate water-borne metal primers free of toxic pigments.

A survey of the industry resulted in the submission of 35 candidate formulations and/or primers. The result of the evaluation conducted demonstrated that none of the products prepared and tested are exactly equal to II-P-1757 "Primer Coating, Zinc Chromate, Low Moisture-Sensitivity" in corrosion resistance. However, one formulation and one proprietary primer are almost equal to II-P-1757 in performance. In addition, one formulation and two proprietary primers exhibit acceptable performance but require some modification to improve storage stability. On the other hand, six formulations and one proprietary primer are acceptable for use on aluminum but not on steel.

on For	
RE	AI
DTIC TAB	☒
Unannounced	☐
Justification	☐
<i>Aluminum Coating</i>	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	



TABLE OF CONTENTS

<u>Chapter</u>	<u>Page</u>
FOREWARD	i
TABLE OF CONTENTS	ii
LIST OF TABLES	iv
I INTRODUCTION	I-1 to I-2
A. Background	I-1
B. Objective	I-1
C. Requirements	I-2
II TECHNICAL APPROACH	II-1 to II-5
A. Survey	II-1
B. Literature Search	II-1
C. Proprietary Primers	II-1
D. Products Tested	II-1
E. Test Program	II-2
III TEST RESULTS AND DISCUSSION	III-1 to III-8
A. Test Results	III-1
B. VOC	III-1
C. Salt Fog Exposure	III-1
D. Discussion of Results	III-1
IV CONCLUSIONS	IV-1 to IV-3
V RECOMMENDATIONS	V-1
VI DISTRIBUTION LIST	VI-1

TABLE OF CONTENTS (Cont)

Appendix

	<u>Page</u>
A. Publicity	A1 to A8
A-1 Letter to Publications	A1
A-2 Publicity Releases	A2
A-3 Letter to Polymer Manufacturers	A3
A-4 Letter to Pigment Manufacturers	A4
A-5 Letter to Additive Manufacturers	A5
A-6 Display at Paint Show	A6
A-7 Letter to Proprietary Primer Manufacturers	A7
B. Test Data	B1 to B10
B-1 Formulated Primers	B1
B-2 Submitted by Raw Material Suppliers	B5
B-3 Proprietary Primers	B7
C. Formulations	C1 to C25
C-1 F Series Formulated Primers	C1
C-2 S Series Submitted by Raw Material Suppliers	C16
C-3 Sources of Raw Materials	C24
D. Sources of Formulations or Primers	D1 to D3
E. Test Procedure	E1 to E2
F. Code and Abbreviations	F1

LIST OF TABLES

<u>Table</u>		<u>Page</u>
II-1	Primers Tested	II-4
III-1	Criteria	III-2
III-2	Data Analysis - Formulated Primers	III-4
III-3	Data Analysis - Submitted by RM Suppliers	III-6
III-4	Data Analysis - Proprietary Primers	III-7

I

INTRODUCTION

A. BACKGROUND

The paints and coatings used on steel and aluminum Army equipment usually consist of two essential types of products: an anti-corrosive primer applied directly on the metal substrate and a topcoat. The primer is used to assure adhesion to the substrate and to prevent corrosion. The topcoat is used to provide the desired appearance, e.g. camouflage, and to protect the primer from the weather, fuel spills, abrasion, etc.

The primers presently used contain volatile organic solvents, including aliphatic or aromatic hydrocarbons, which serve a number of important functions. They reduce viscosity to enable proper and rapid application, e.g., by spray, to improve wetting and thus assure ultimate adhesion to the substrate, and to improve leveling thus producing a smooth paint film free of defects such as orange peel, runs, etc.

These primers develop their corrosion resistance from the use of corrosion-inhibiting pigments. The most effective anti-corrosive pigments presently used are based either on lead or Chromium VI, both of which are toxic.

Because of the increased concern regarding health and safety, as well as both current and anticipated governmental regulations to control pollution of the environment by volatile organic compounds, there is a need for the development of water-borne corrosion-inhibiting primers that are also free of toxic pigments, such as those containing lead and Chromium VI. However, neither the desired formulations nor the data required to confirm their utility for Army equipment are readily available.

Consequently, it was necessary to determine the latest technology on this subject, locate candidate formulations and raw materials, prepare these formulations and evaluate their performance vs the important properties desired for this end use.

B. OBJECTIVE

The purpose of this program was to formulate and evaluate lead and Chromium VI-free, water-borne corrosion-inhibiting primers that can be applied on both ferrous and aluminum substrates. These primers should be as corrosion resistant as the organic solvent-thinned primers presently used, in order to have the potential of replacing the latter for use on Army mobility equipment.

C. REQUIREMENTS

The primers to be formulated should meet the following requirements:

1. They should contain no lead or Chromium VI.
2. They should contain a maximum of 3.5 lbs/gal (420 gms/liter) of volatile organic compounds (VOC) as applied.
3. The solvents in the primers should be exempt, i.e., they should conform to Rule 66 or Rule 102 of the Southern California Air Pollution Control District (SCAPCD).
4. The polymers in the primers may be either water emulsifiable or water soluble. They should be based on acrylic, alkyd, epoxy, urethane or butadiene-styrene polymers or modified polymers.

These primers should also meet the following physical and performance requirements:

1. Acceptable package stability after accelerated storage of four weeks at 125°F.
2. Good freeze-thaw stability.
3. A flash point of at least 100°F.
4. Thinnable with water to both brush and spray viscosities.
5. Applicable by conventional equipment.
6. Air dry tack-free within 6 hours.
7. Show no flash rusting when applied.
8. Pass a 144 hour exposure to salt fog.

II

TECHNICAL APPROACH

A. SURVEY

The first step was to publicize the interest of US AMERADCOM and thus encourage submission of recommended formulations and raw materials. This was done by distributing a Publicity Release to all of the major Paint and Coatings publications as well as Chemical Week and Chemical and Engineering News. See Appendix A1 and A2.

The second step was to write directly to the major suppliers of polymers, non-toxic corrosion-inhibiting pigments and additives, e.g. adhesion promoters and rust-preventive compounds. See Appendix A3 thru A5.

A third step was to publicize the program by a display at the D/L Laboratories booth in the Paint Industries Show at the Annual Paint And Coatings Convention in Detroit, Michigan, October 28 - 30, 1981. See Appendix A-6.

B. LITERATURE SEARCH

All major paint and coatings publications for the past five years were reviewed to obtain recommendations on formulating primers to meet the above criteria.

C. PROPRIETARY PRIMERS

One result of the survey was the offer by many paint and coating manufacturers to submit proprietary primers for the test program.

This was discussed with the CTR and it was decided to modify the program to allow the inclusion of proprietary, as well as formulated primers, and thus improve the potential for obtaining acceptable products which would meet the criteria. All suppliers were advised that they would have to submit an analysis if their products were accepted as candidates and were assured that such information would be kept strictly confidential. See Appendix A-7. A-7.

D. PRODUCTS TESTED

A total of 35 apparently acceptable formulations or primers were selected for test. They are as follows:

15 Formulations

9* Primers submitted (with formulations)
 by raw material suppliers

11 Proprietary primers

The products tested are listed in Table II-1. The formulations are shown in Appendix C and the complete names, addresses and contacts for the suppliers are listed in Appendix D.

- * One primer (S-9) was rejected because of an excess concentration of VOC.

E. TEST PROGRAM

1. Data Review and Product Selection

A considerable amount of data, as well as formulations, were received from raw material suppliers, both those surveyed and in answer to the publicity and display at the D/L Laboratories booth in the Paint Industries Show. In addition, many paint manufacturers offered to submit proprietary primers which had not been considered originally.

These were reviewed carefully in order to choose formulations which met the analytical criteria, primarily for the absence of lead and Chromium VI compounds, VOC concentrations below 3.5 lbs per gal. of paint and the potential of meeting the physical and performance criteria.

Inasmuch as the paint manufacturers could not be expected to divulge the formulations of their primers, they were asked to confirm that their products met the criteria, with the understanding that the VOC would be determined by the D/L Laboratories and that the analyses of their products would be divulged to AMERADCOM under a confidentiality agreement.

2. Paint Preparation

Samples of the raw materials required to prepare the acceptable formulations were obtained and these formulations were prepared. However, nine raw material suppliers offered to prepare their formulations and submit the finished primers. Their offers were accepted as a means of increasing the total number of formulations which could be evaluated within the financial limitations of the contract.

3. Test Procedure

The following properties were tested. The test methods used are described in Appendix E.

- | | |
|----------------------|-------------|
| 1. VOC | ASTM D-3960 |
| 2. Weight per Gallon | ASTM D-1475 |
| 3. Total Solids | ASTM D-2832 |
| 4. Flash Point | ASTM D-93 |

- | | | |
|-----|---|------------------------------|
| 5. | Viscosity | ASTM D-562 |
| | Initial | |
| | 4 weeks at 125°F | ASTM D-1849 |
| | Freeze-thaw | ASTM D-2243 |
| 6. | Storage Stability | ASTM D-1849 |
| | Liquid separation | |
| | Skinning | |
| | Pigment settling | |
| | Ease of remixing | |
| 7. | Speed of Dry | ASTM D-1640 |
| | Set to touch | |
| | Dry tack free | |
| | Dry hard | |
| | Dry thru | |
| 8. | Sprayability | Federal 141B,
Method 4331 |
| 9. | Brushability | Federal 141B,
Method 4321 |
| 10. | Adhesion To - | |
| | -Bonderized steel | Federal II-P-141B |
| | -Aluminum | Method 6304 |
| 11. | Salt Fog Exposure - 144 hours | ASTM B-117 |
| | a) Applied on Bonderized steel at 1.0 mil dft | |
| | b) Ditto at 1.5 mils dft | |
| | c) Applied on aluminum at 1.0 mil dft | |
| | d) Ditto at 1.5 mils dft | |
| | Record - | |
| | (1) Blistering - at X score | |
| | (2) - overall | |
| | (3) Corrosion - at X score | |
| | (4) - overall | |

dft - dry film thickness

TABLE II-1 PRIMERS TESTED

<u>Code</u>	<u>Number</u>	<u>Supplier</u>
<u>Prepared Formulations</u>		
F-1	FX-8	Buckman Laboratories
F-2	P-1686-116-3	Cargill
F-3	5727 C	Halox Pigments
F-4	7585 D	Halox Pigments
F-5	None	Mineral Pigments
F-7	137-68	PVO International
F-8	PWB-76	Reichard Coulston
F-9	KK-1006-7A	Reichard Coulston
F-10	1855-32A	Spencer Kellogg
F-11	2007-10-1	Spencer Kellogg
F-12	RM-3	Wet Ground Mica Association
F-13	RN-3	Wet Ground Mica Association
F-14	30708-2	Celanese
F-15	30708-3	Celanese
F-16	30708-4	Celanese
<u>Submitted Formulations</u>		
S-1	CAS 1795	Rohm and Haas
S-2	ESA 1136	Rohm and Haas
S-3	ESA 1252-3	Rohm and Haas
S-4	ESA 1255-1	Rohm and Haas
S-5	FL 2915	Rohm and Haas
S-6	Haloflex 202 Primer	ICI Americas
S-7	191	Polyvinyl Chemical
S-8	14JG-74A	Union Carbide

TABLE II-1 PRIMERS TESTED (Cont)

<u>Code</u>	<u>Number</u>	<u>Supplier</u>
<u>Proprietary Primers</u>		
M-1	931-R-4901	Fuller O'Brien
M-2	Quick Dry Latex Primer	DeVoe Marine
M-3	White Latex Primer	DeVoe Marine
M-4	DeV-258 Red	DeVoe Marine
M-5	DeV-259 White	DeVoe Marine
M-6	SA7981-G73	Sherwin-Williams
M-7	SA8367-G73	Sherwin-Williams
M-8	C-1501	General Electric
M-9	Rustex	Advanced Paint
M-10	Primer W	Advanced Paint
M-11	99X-0106 Gray	Stanchem

The full names and addresses of the suppliers are shown in Appendix D.

III

TEST RESULTS AND DISCUSSION

A. TEST RESULTS

The test data are shown in the following Appendices:

B-1 Formulated Primers

B-2 Primers Submitted by Raw Material Suppliers

B-3 Proprietary Primers

B. VOC

The first test conducted was for volatile organic compounds (VOC). Only one product failed - No. S-9, Formulation D-30901 of Lorcon Chemical. It had a VOC of 440 gms/liter (3.7 lbs/gal).

C. SALT FOG EXPOSURE

Inasmuch as salt fog (corrosion) resistance is of paramount importance, the evaluation program was modified, at the request of the CTR, to not only test all formulations and proprietary primers submitted but to also do so on panels prepared at two film thicknesses (1.0 and 1.5 mils dry film thickness) and on two substrates (Bonderized steel and aluminum). II-P-1757 "Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity" was used as the control.

Additionally, the original scope of the contract was further modified to include painted panels of all coatings applied on both metals and at both film thicknesses to be submitted to the CTR for test at the AMERADCOM laboratories.

All exposure tests were conducted in duplicate. All panels were scored with an "X" covering the bottom half of each panel.

D. DISCUSSION OF RESULTS

The primers tested can be rated for acceptability by rating their performance using the criteria listed in the introduction. However, because of the problem inherent in this new technology, namely to readily match the performance of conventional metal primers, a marginal category has been added, in which the performance of the primer is just below the desired level.

The criteria used in rating the primers are shown in Table III-1 and the ratings, both Acceptable and Marginal, are shown in the following tables:

III-2 Data Analysis - Formulated Primers

III-3 Data Analysis - Primers Submitted by RM Suppliers

III-4 Data Analysis - Proprietary Primers

TABLE III-I CRITERIA

	<u>Property</u>	<u>Acceptable</u>	<u>Marginal</u>
1	VOC	Below 420 gm/liter or 3.5 lbs/gal	-
2	Flash Point	100°F+	
3	Viscosity	60-100 KU	Below 60, 100-130 KU
4	Viscosity Stability (Heat or Freeze Test)	Maximum change - below 40 KU	Max. = Above 40 KU but no solidification or coagulation
5	Storage Stability	Score of 6+ for all observations	Score of 4 for all observations
6	Speed of Dry	6 hours max. for all tests	Tack free - - 6 hours max. Dry hard - O/N Dry thru - O/N
7	Sprayability	Score of 6+	Score of 4
8	Brushability	Score of 6+	Score of 4
9	Adhesion	Score of 10	Score of 8
10	Salt Fog Resistance Blistering Corrosion	Max. - 8F or 9M Score of 8+	Max. - 6F or 8M Score of 6+

10 = Perfect
8 = Very good
6 = Good
4 = Fair

O/N - Overnight

Note: Weight per Gallon and Total Solids have not been included as criteria since they are production control tests and therefore of no significance in rating the performance of these products.

The following information is not shown in these tables:

1. **Lead and Chromium VI Compounds** - Any formulation found to contain either was rejected immediately and not tested. All proprietary primers tested are claimed to have neither.
2. **Weight per Gallon** - This is used primarily as a production control check and should have no effect on performance.
3. **Total Solids** - The same applies to this determination.

The following properties are of relatively minor importance and are so noted in the tables:

1. **Viscosity** - This of relatively minor importance provided that other properties are not adversely affected, e.g., excessive pigment settling, if viscosity is too low, or hard brushing, if viscosity is too high.
2. **Accelerated viscosity and storage stability** - The test is considered to be equivalent to at least six months of storage. Normally, industrial coatings are used essentially as soon as received so that long term storage is not a serious problem.
3. **Freeze-thaw Stability** - Water thinned coatings should be shipped and stored in controlled environments to prevent the possibility of freezing.
4. **Brushability** - These coatings are normally sprayed so that brushability is not critical.

TABLE III-2 DATA ANALYSIS-FORMULATED PRIMERS

	<u>F-1</u>	<u>F-2</u>	<u>F-3</u>	<u>F-4</u>	<u>F-5</u>	<u>F-7</u>	<u>F-8</u>	<u>Minor</u>
VOC	A	A	A	A	A	A	A	
Flash Point	A	A	A	A	A	A	A	
Viscosity	A	M	M	M	A	A	A	xx
Stability-Heat test	F	F	A	A	A	A	A	xx
" -Freeze thaw	F	A	A	A	A	F	A	xx
Storage Stability	F	F	A	A	A	F	M	xx
Speed of Dry	A	A	A	A	A	F	A	
Sprayability	A	A	A	A	X	A	A	
Brushability	A	M	F	A	A	A	A	xx
Adhesion To -								
- Steel	A	A	A	A	X	A	A	
- Aluminum	A	A	A	A	X	A	A	
Salt Fog Resistance								
Steel								
1.0 mil dft	F	M	M	A	X	F	F	
1.5 mil dft	F	M	M	A	X	M	F	
Aluminum								
1.0 mil dft	A	A	M	A	X	A	A	
1.5 mil dft	A	A	A	A	X	A	A	

A - Acceptable
M - Marginal
F - Failed

X - Not tested due to flash rusting on steel
xx - Property of relatively minor importance
dft - Dry film thickness

TABLE III-2 DATA ANALYSIS-FORMULATED PRIMERS

	<u>F-9</u>	<u>F-10</u>	<u>F-11</u>	<u>F-12</u>	<u>F-13</u>	<u>F-14</u>	<u>F-15</u>	<u>F-16</u>	<u>Minor</u>
VOC	A	A	A	A	A	A	A	A	
Flash Point	A	A	A	A	A	A	A		
Viscosity	A	M	A	A	A	A	A	F	xx
Stability-Heat test	F	F	F	M	M	F	A	F	xx
"-Freeze thaw	A	A	A	A	A	A	A	A	xx
Storage Stability	F	F	F	F	A	F	A	F	xx
Speed of Dry	A	A	F	A	A	M	M	M	
Sprayability	A	A	A	A	A	A	A	A	
Brushability	A	A	A	A	A	A	A	A	xx
Adhesion To -									
- Steel	A	A	A	A	A	A	A	A	
- Aluminum	A	A	A	A	A	A	A	A	
Salt Fog Resistance									
Steel									
1.0 mil dft	F	M	M	F	M	M	A	M	
1.5 mil dft	F	F	A	M	F	A	A	A	
Aluminum									
1.0 mil dft	A	F	A	A	A	A	A	A	
1.5 mil dft	A	F	A	A	A	A	A	A	

TABLE III-3 DATA ANALYSIS SUBMITTED BY RM SUPPLIERS

	<u>S-1</u>	<u>S-2</u>	<u>S-3</u>	<u>S-4</u>	<u>S-5</u>	<u>S-6</u>	<u>S-7</u>	<u>S-8</u>	<u>Minor</u>
VOC	A	A	A	A	A	A	A	A	
Flash Point	A	A	A	A	A	A	A	A	
Viscosity	A	M	M	F	M	A	M	A	xx
Stability-Heat test	M	A	A	A	A	A	A	A	xx
" -freeze thaw	F	A	A	A	A	F	F	A	xx
Storage Stability	F	F	A	F	A	A	F	A	xx
Speed of Dry	A	A	A	A	A	A	A	A	
Sprayability	A	A	A	A	A	A	A	A	
Brushability	A	A	A	A	A	A	A	A	xx
Adhesion To -									
- Steel	A	A	A	A	A	A	A	A	
- Aluminum	A	A	A	A	A	A	A	A	
Salt Fog Resistance									
Steel									
1.0 mil dft	F	F	F	M	F	F	M	F	
1.5 mil dft	F	A	M	A	F	F	M	F	
Aluminum									
1.0 mil dft	A	A	A	A	A	A	M	A	
1.5 mil dft	A	A	A	A	A	A	A	A	

TABLE III-4 DATA ANALYSIS - PROPRIETARY PRIMERS

	<u>M-1</u>	<u>M-2</u>	<u>M-3</u>	<u>M-4</u>	<u>M-5</u>	<u>Minor</u>
VOC	A	A	A	A	A	
Flash Point	A	A	A	A	F	
Viscosity	M	A	A	A	M	xx
Stability - Heat test	A	A	A	M	M	xx
" - Freeze thaw	F	F	M	A	A	xx
Storage Stability	F	M	F	A	A	xx
Speed of Dry	A	A	A	X	F	
Sprayability	A	A	A	A	A	
Brushability	A	A	A	A	A	xx
Adhesion To -						
- Steel	A	A	A	A	A	
- Aluminum	A	A	A	A	A	
Salt Fog Resistance						
Steel						
1.0 mil dft	M	F	F	X	F	
1.5 mil dft	M	F	F	X	F	
Aluminum						
1.0 mil dft	A	F*	A	X	A	
1.5 mil dft	A	F*	A	X	A	

X - Not tested due to extreme grit
 * - Panels pitted due to low pH

TABLE III-4 DATA ANALYSIS - PROPRIETARY PRIMERS

	<u>M-6</u>	<u>M-7</u>	<u>M-8</u>	<u>M-9</u>	<u>M-10</u>	<u>M-11</u>	<u>Minor</u>
VOC	A	A	A	A	A	A	
Flash Point	A	A	A	F	A	A	
Viscosity	A	A	M	A	A	A	xx
Stability - Heat test	F	F	A	A	A	A	xx
" - Freeze thaw	A	A	A	-	A	F	xx
Storage Stability	F	F	A	M	A	A	xx
Speed of Dry	A	A	A	F	A	A	
Sprayability	A	A	A	A	A	A	
Brushability	A	A	A	A	F	A	xx
Adhesion To -							
- Steel	A	A	A	A	A	A	
- Aluminum	A	A	A	A	A	A	
Salt Fog Resistance							
Steel							
1.0 mil dft	A	A	A	F	F	F	
1.5 mil dft	A	A	A	A	F	F	
Aluminum							
1.0	A	A	A	A	F	A	
1.5 mil dft	A	A	A	A	M	A	

- Not applicable, solvent-thinned

IV

CONCLUSIONS

The following conclusions may be drawn from the results of the evaluation. Note that the deficiencies observed for each primer tested are also included. They are listed by group, in order of corrosion resistance, and numerically within groups:

1. The following primers are the best of all tested and essentially meet the corrosion resistance requirements of TT-P-1757:

F-4, No. 7585D	Haolx Pigments
Slightly high viscosity	
F-15, No. 30708-3	Celanese Chemicals
Slightly slow drying speed	
M-6, No. SA7981-G73	Sherwin-Williams
Fails accelerated heat storage test - a minor deficiency.	
M-7, No. SA8367-G73	Sherwin-Williams
Same as M-6	
M-8, No. C-1501	General Electric Co.
Slightly low viscosity	

2. The following primers exhibit acceptable corrosion resistance when used on aluminum and marginal corrosion resistance when used on steel:

F-2, No. P-1686-116-3	Cargill
Slightly high viscosity, fails heat storage and brushing tests, both of which are minor deficiencies.	
F-14, No. 30708-2	Celanese Chemicals
Fails heat storage test, a minor deficiency, and slightly slow dry.	
F-16, No. 30708-4	Celanese Chemicals
High viscosity and fails heat storage tests, both minor deficiencies, slightly slow dry.	
S-4, No. ESA 1255-1	Rohm and Haas
High viscosity and fails storage stability test, both minor deficiencies.	

M-1, No. 931-R-4901

Fuller O'Brien

Slightly low viscosity, fails freeze-thaw and storage stability tests, all minor deficiencies.

3. The following primers exhibit acceptable corrosion resistance when used on aluminum but fail when used on steel:

F-1, No. FX-8

Buckman Laboratories

Fails accelerated heat storage and freeze-thaw tests, both minor deficiencies.

F-8, No. PWB-76

Reichard Coulston

Marginal storage stability, a minor deficiency.

F-9, No. KK-1006-7A

Reichard Coulston

Fails accelerated heat storage test, a minor deficiency.

F-12, No. RM-3

Wet Ground Mica Assoc.

Same as F-9 above.

F-13, No. RN-3

Wet Ground Mica Assoc.

Marginal heat storage stability, a minor deficiency.

S-1, No. CAS 1795

Rohm and Haas

Fails accelerated heat storage and freeze-thaw tests, both minor deficiencies.

S-2, No. ESA 1136

Rohm and Haas

Slightly high viscosity and fails storage stability test, both minor deficiencies.

S-3, No. ESA 1252-3

Rohm and Haas

Slightly high viscosity, a minor deficiency.

S-5, No. FL 2915

Rohm and Haas

Same as S-3 above.

S-6, Haloflex 202 Primer

ICI Americas

Fails freeze-thaw, a minor deficiency.

S-8, No. 14JG-74A

Union Carbide

No other defects.

- M-3, White Latex Primer DeVoe Marine
Marginal freeze-thaw resistance and fails storage stability test, both minor deficiencies.
- M-11, No 99X-0106 Gray Stanchem
Fails freeze-thaw, a minor deficiency.
4. The following primers exhibit marginal corrosion resistance when applied on either steel or aluminum:
- F-3, No. 5727c Halox Pigments
Slightly high viscosity and hard brushing, both minor deficiencies.
- S-7, No. 191 Polyvinyl Chemical
Slightly high viscosity and fails freeze-thaw and storage stability tests, all minor deficiencies.
5. The following primers are not acceptable because of serious deficiencies:
- F-5, No number Mineral Pigments
Excessive flash rusting
- F-7, No. 137-68 PVO International
Very slow drying
- F-10, No. 1855-32A Spencer Kellogg
Poor corrosion resistance when applied on either steel or aluminum.
- F-11, No. 2007-10-1 Spencer Kellogg
Very slow drying
- M-2, Quick Dry Latex Primer DeVoe Marine
Poor corrosion resistance when applied on either steel or aluminum.
- M-4, DeV-258 Red DeVoe Marine
Extremely gritty
- M-5, DeV-259 White DeVoe Marine
Low flash point, very slow drying

M-9, Rustex

Advanced Paint

Low flash point, very slow drying.

M-10, Primer W

Advanced Paint

Poor corrosion resistance when applied on
either steel or aluminum.

6. The major problem, overall, is adequate corrosion resistance when applied on steel. The second major problem is excessive change in viscosity or coagulation during the accelerated storage test, either hot or cold. All other deficiencies are relatively minor or scattered.

RECOMMENDATIONS

The following recommendations are offered to exploit the favorable results of this investigation and to continue efforts where there is a potential of improving the results obtained:

1. Conduct field tests on the following 5 primers applied on both steel and aluminum:

F-4,	No. 7585D	Halox Pigments
F-15,	No. 30708-3	Celanese Chemicals
M-6,	No. SA7981-G73	Sherwin-Williams Co.
M-7,	No. SA8367-G73	Sherwin-Williams Co.
M-8,	No. C-1501	General Electric Co.

2. Conduct field tests on the following 18 primers for use on aluminum substrates only:

F-1	No. FX-8	Buckman Laboratories
F-2	No. P-1686-116-3	Cargill
F-8	No. PWP-76	Reichard Coulston
F-9	No. KK-1006-7A	Reichard Coulston
F-12	No. RM-3	Wet Ground Mica Assoc.
F-13	No. RN-3	Wet Ground Mica Assoc.
F-14	No. 30708-2	Celanese Chemicals
F-16	No. 30708-4	Celanese Chemicals
S-1	No. CAS 1795	Rohm and Haas
S-2	No. ESA 1136	Rohm and Haas
S-3	No. ESA 1252-3	Rohm and Haas
S-4	No. ESA 1255-1	Rohm and Haas
S-5	No. FL 2915	Rohm and Haas
S-6	Haloflex 202 Primer	ICI Americas
S-8	No. 14JG-74A	Union Carbide
M-1	No. 931-R-4901	Fuller O'Brien
M-3	White Latex Primer	DeVoe Marine
M-11	No. 99X-0106 Gray	Stanchem

3. Conduct reformulation studies on the following formulations in order to improve the deficiencies observed (see Conclusion No. 1 above) without adversely affecting corrosion resistance:

F-4,	No. 7585D	Halox Pigments
F-15,	No. 30708-3	Celanese Chemicals

4. Request the suppliers to modify the following formulations in order to overcome the deficiencies observed (see Conclusion No. 1 above) without adversely affecting corrosion resistance:

M-6,	No. SA7981-G73	Sherwin-Williams
M-7,	No. SA8367-G73	Sherwin-Williams
M-8,	No. C-1501	General Electric Co.

5. Modify the following formulations to both improve their marginal corrosion resistance and other defects as well. See Conclusions Nos. 2 and 4 above.

F-2,	No. P-1686-116-3	Cargill
F-3,	No. 5727C	Halox Pigments
F-14,	No. 30708-2	Celanese Chemicals
F-16,	No. 39708-4	Celanese Chemicals
S-4,	No. ESA 1255-1	Rohm and Haas
S-7,	No. 191	Polyvinyl Chemical

6. Request the supplier to modify the following formulation to improve its marginal corrosion resistance as well as other defects. See Conclusion No. 2 above.

M-1,	No. 931-R-4901	Fuller O'Brien
------	----------------	----------------

7. Reformulate the following low VOC primers recommended for use on aluminum only in order to improve their other defects. See Conclusion No. 3 above.

F-1,	No. FX-8	Buckman Laboratories
F-8,	No. PWB-76	Reichard Coulston
F-9,	No. KK-1006-7A	Reichard Coulston
F-12,	No. RM-3	Wet Ground Mica Assoc.
F-13,	No. RN-3	Wet Ground Mica Assoc.
S-1,	No. CAS 1795	Rohm and Haas
S-2,	No. ESA 1136	Rohm and Haas
S-3,	No. ESA 1252-3	Rohm and Haas
S-5,	No. FL 2915	Rohm and Haas

S-6, Haloflex 202 Primer
S-8, No. 14JG-74A

ICI Americas
Union Carbide

8. Request the suppliers of the following low VOC primers, recommended for use on aluminum only, to modify their products in order to improve their other defects. See Conclusion No. 3 above.

M-3, White Latex Primer
M-11, No. 99X-0106 Gray

DeVoe Marine
Stanchem

DISTRIBUTION LIST

<u>Receipient</u>	<u>No. of Copies</u>
DRDME-VO	3
DRDME-TQ	1
DDC	12
DRDME-WC	2



116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410

Appendix A-1

(FORMERLY DAVID LITTER LABORATORIES)

Letter to Publications

Re: PUBLICITY RELEASE

As you probably know, government regulations are severely controlling the content of our paints and coatings, especially with respect to air polluting solvents and toxic pigments.

The Armed Forces are not exempt from these regulations and therefore are attempting to meet them without degrading the performance of the paints and coatings they use. One of the steps being undertaken by the U.S. Army Mobility Equipment Research & Development Command is to develop new metal primer specifications to replace the conventional coatings presently used. In order to do so within a reasonable time, it is necessary to alert raw material suppliers to the proposed plan so that their products can be submitted as soon as possible.

We would therefore, appreciate your inserting the enclosed Publicity Release in an early issue of your publication. Please send us two copies of the printed release.

Thank you for your cooperation.

Sincerely,

Sidney B. Levinson
President

SBL/df
cc: S. Spindel

enc.



(ESTABLISHED 1952)

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410 TWX: 710-581-6132

Publicity Release

Re: U.S. ARMY SEEKING WATER-BORNE PRIMERS

The U.S. Army Mobility Equipment Research & Development Command is responsible for the development of paints and coatings for all Army equipment. At present, conventional coatings are in use but the Command is under pressure to meet current and anticipated restrictions on the content of volatile organic materials, as well as toxic inhibiting pigments, in these primers.

Therefore, a contract has been awarded to the D/L Laboratories to investigate, formulate and evaluate water borne metal primers which contain no lead or Chromium VI.

The following parameters have been specified:

1. Contain no lead or Chromium VI.
2. Contain a maximum of 3.5 lbs/gal of volatile organic compounds (VOC) when applied.
3. Solvents present shall meet Rule 66 or Rule 102 of SCAPCD.
4. Shall be capable of conventional application.
5. Shall be air drying.

The polymers used in these primers may be either water emulsifiable or water soluble provided that they meet these requirements.

The cooperation of the industry is solicited. Representatives of companies wishing to have their anti-corrosive pigment(s) or water borne polymer(s) included in this program, should call or write: Sidney B. Levinson, President, D/L Laboratories, 116 East 16th Street, New York, N.Y. 10003; (212) 777-4410.

Sincerely,

SBL/df
cc: S. Spindel

Sidney B. Levinson
President



Appendix A-3

(ESTABLISHED 1952)

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410 TWX: 710-581-6132

Letter to Polymer Manufacturers

Re: LEAD AND CHROME FREE WATER BORNE PRIMERS

The U.S. Army Mobility Equipment Research & Development Command is responsible for the development of paints and coatings for all Army equipment. At present, conventional coatings are in use but the Command is under pressure to meet current and anticipated restrictions on the content of volatile organic materials, as well as toxic inhibiting pigments, in these primers. Therefore, a contract has been awarded to the D/L Laboratories to investigate, formulate and evaluate water borne metal primers which contain no lead or Chromium VI.

The following parameters have been specified:

1. Contain no lead or Chromium VI.
2. Contain a maximum of 3.5 lbs/gal of volatile organic compounds (VOC) when applied.
3. Solvents present shall meet Rule 66 or Rule 102 of SCAPCD.
4. Shall be capable of conventional application.
5. Shall be air drying.

If you have any water borne polymers you wish to have included in this program, will you please submit (a) gallon sample (s). Also please send us your data and recommended metal primer formulations, if available.

Thank you for your cooperation.

Sincerely,

SBL/df
cc: S. Spindel

Sidney B. Levinson
President



Appendix A-4

(FORMERLY DAVID LITTER LABORATORIES)

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410

Letter to Pigment Manufacturers

Re: LEAD AND CHROME FREE WATER BORNE PRIMERS

The U.S. Army Mobility Equipment Research & Development Command is responsible for the development of paints and coatings for all Army equipment. At present, conventional coatings are in use but the Command is under pressure to meet current and anticipated restrictions on the content of volatile organic materials, as well as toxic inhibiting pigments, in these primers. Therefore, a contract has been awarded to the D/L Laboratories to investigate, formulate and evaluate water borne metal primers which contain no lead or Chromium VI.

The following parameters have been specified:

1. Contain no lead or Chromium VI.
2. Contain a maximum of 3.5 lbs/gal of volatile organic compounds (VOC) when applied.
3. Solvents present shall meet Rule 66 or Rule 102 of SCAPCD.
4. Shall be capable of conventional application.
5. Shall be air drying.

If you have any anti-corrosive pigments you wish to have included in this program, will you please submit (a) 10 lb. sample(s). Also please send us your data and recommended metal primer formulations, if available.

Thank you for your cooperation.

Sincerely,

SBL/df
cc: S. Spindel

Sidney B. Levinson
President

A-4



Appendix A-5

(FORMERLY DAVID LITTER LABORATORIES)

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410

Letter to Additive Manufacturers

Re: LEAD AND CHROME FREE WATER BORNE PRIMERS

The U.S. Army Mobility Equipment Research & Development Command is responsible for the development of paints and coatings for all Army equipment. At present, conventional coatings are in use but the Command is under pressure to meet current and anticipated restrictions on the content of volatile organic materials, as well as toxic inhibiting pigments, in these primers. Therefore, a contract has been awarded to the D/L Laboratories to investigate, formulate and evaluate water borne metal primers which contain no lead or Chromium VI.

The following parameters have been specified:

1. Contain no lead or Chromium VI
2. Contain a maximum of 3.5 lbs/gal of volatile organic compounds (VOC) when applied.
3. Solvents present shall meet Rule 66 or Rule 102 of SCAPCD.
4. Shall be capable of conventional application.
5. Shall be air drying. .

If you have any corrosion inhibitors or adhesion promoters you wish to have included in this program, will you please submit (a) one pound sample (s). Also please send us your data and recommended metal primer formulations, if available.

Thank you for your cooperation.

Sincerely,

SBL/df
cc: S. Spindel

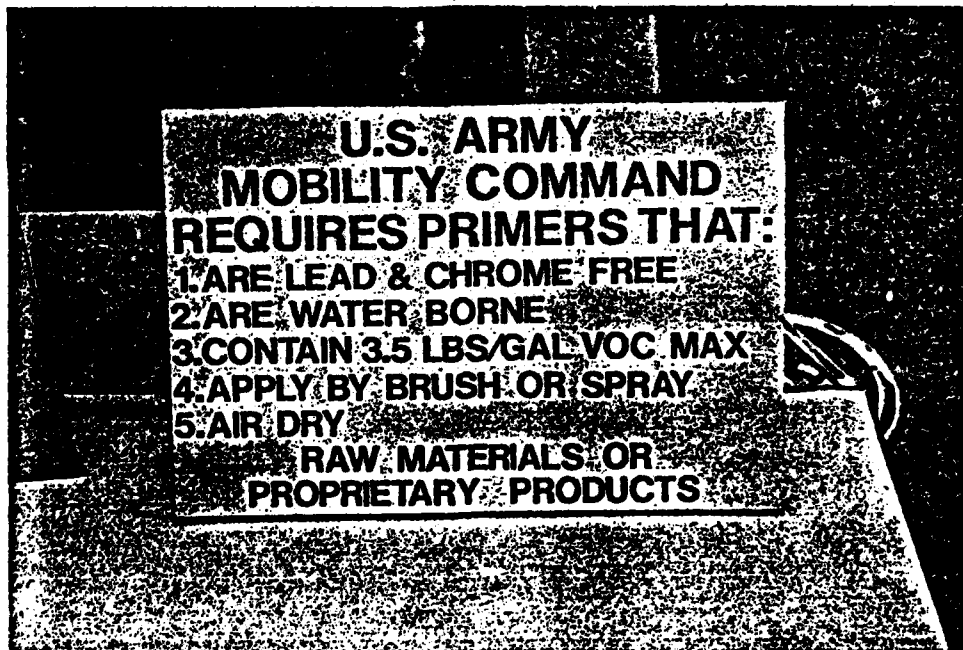
A-5

Sidney B. Levinson
President

MARKET RESEARCH & DEVELOPMENT, TESTING & EVALUATION, FORMULATION, PREPARATION OF SPECIFICATIONS & MANUALS,
INSPECTION & CERTIFICATION, PERSONNEL TRAINING & LEGAL ASSISTANCE FOR THE PROTECTIVE COATINGS & ALLIED INDUSTRIES

Appendix A-6

Display at Paint Show





116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410

Letter to Metal Primer Manufacturers

Re: LEAD AND CHROME FREE WATER BORNE PRIMERS

The U.S. Army Mobility Equipment Research & Development Command is responsible for the development of paints and coatings for all Army Equipment. At present, conventional coatings are in use but the Command is under pressure to meet current and anticipated restrictions on the content of volatile organic materials, as well as toxic inhibiting pigments, in these primers. Therefore, a contract has been awarded to the D/L Laboratories to investigate, formulate and evaluate water borne metal primers which contain no lead or Chromium VI.

The following parameters have been specified:

1. Contain no lead or Chromium VI.
2. Contain a maximum of 3.5 lbs/gal of volatile organic compounds (VOC) when applied.
3. Shall be capable of conventional application.
4. Shall be air drying.

The formulations developed should conform to the corrosion inhibiting requirements of the following organic solvent primers or rust-inhibiting coatings:

TT-E-485	Enamel, Semigloss, Rust-Inhibiting.
TT-P-636	Primer Coating, Alkyd, Wood & Ferrous Metal.
TT-P-664	Primer Coating, Synthetic, Rust-Inhibiting, Lacquer Resisting.



116 East 16th Street, New York, N.Y. 10003

-2-

TI-P-1757 Primer Coating, Zinc Chromate, Low Moisture-Sensitivity.

MIL-P-23377 Primer Coating, Epoxy-Polyamide, Chemical and Solvent Resistant.

They should also meet the following specific requirements:

- a. A projected package stability of at least one year.
- b. Good freeze-thaw stability.
- c. A flash point above 100°F.
- d. Thinnable with water to both brushing and spray viscosities.
- e. Air dry tack free within 6 hours.
- f. Show no flash rusting when applied on steel substrates.
- g. Compatability with both conventional organic solvent and water borne topcoats.
- h. Pass a 144 hour exposure to 5% salt fog.
- i. Pass water and hydrocarbon immersion resistance tests without a top coat.

Although our contract calls for the formulation of the primers, we have been given approval to evaluate proprietary products provided that their formulations are divulged to US AMERADCOM under a confidentiality agreement.

If this is acceptable to you, please forward at least two quarts of each product with the following information:

1. VOC concentration in g/l or lbs/gal, less water.
2. Flash point
3. Instructions for use.

Thank you for your interest.

Sincerely,

Appendix B-1

Formulated Primers

TEST DATA

	F-1	F-2	F-3	F-4	F-5	F-7	F-8
VOC (as applied)	101 0.8	324 2.7	348 2.9	216 1.8	216 1.8	6 0.1	159 1.3
Weight per Gallon	10.47	10.86	10.26	9.70	10.67	10.44	11.19
Total Solids	51.6	52.4	47.9	43.3	43.3	60.9	58.3
Flash Point	150+	150+	139	150+	150+	150+	150+
Viscosity Initial	61	102	122	115	64	61	78
4 weeks at 125°F	Sol	Coag	119	141+	63	54	68
Freeze-thaw	Coag	110	116	141	74	Coag	75
Storage Stability							
Liquid separation	9	2	8	8	8	2	4
Skimming	2	10	6	10	10	10	10
Pigment settling	9	10	6	9	9	2	6
Ease of remixing	0	0	8	9	9	2	4
Speed of Dry							
Set to touch							
Dry tack free	0.3	0.4	0.3	0.2	0.4	0.4	0.2
Dry hard	0.6	1.6	5.5	4.5	1.4	0.5	2.1
Dry thru	0.6	1.6	6.0	4.5	1.4	0.8	2.1
	0.7	1.8	4.0	3.5	1.8	24+	3.1
Sprayability	10	10	10	10	*	10	10
Brushability	10	4	2	6	10	10	8
Adhesion To -							
Bonderized steel	10	10	10	8	*	10	10
Aluminum	10	10	10	10	*	10	10
Sol - Solidified							

* Flash rust - sample rejected

Coag - Coagulated

Sol - Solidified

Appendix B-1 (Cont)

Formulated Primers

TEST DATA

	F-9	F-10	F-11	F-12	F-13	F-14	F-15	F-16
VOC (as applied)	324 2.7	258 2.2	252 2.1	85 0.7	80 0.7	300 2.5	300 2.5	300 2.5
Weight per Gallon	10.03	10.35	10.52	12.11	11.58	10.63	10.60	10.63
Total Solids	51.7	48.1	50.0	57.3	53.6	69.7	69.5	59.7
Flash Point	131	115	150+	150+	150+	107	100	117
Viscosity								
Initial	80	132	65	70	72	95	95	141+
4 weeks at 125°F	Sol	Coag	Coag	141+	123	Coag	106	Coag
Freeze-thaw	82	141+	60	72	80	88	88	141+
Storage Stability								
Liquid separation	2	2	2	8	8	6	8	8
Skimming	0	9	9	2	6	10	8	10
Pigment settling	0	6	10	9	9	10	10	10
Ease of remixing	0	0	0	9	9	0	9	0
Speed of Dry						*		*
Set to touch	0.2	0.4	0.4	0.4	0.4		0.5	
Dry tack free	0.6	1.0	O/N	0.5	0.4		5.0	
Dry hard	1.2	2.0	O/N	0.6	0.5		O/N	
Dry thru	1.7	2.5	O/N	0.8	0.7		O/N	
Sprayability	10	10	10	10	10	10	10	10
Brushability	6	8	8	10	10	8	10	8
Adhesion To -								
Bonderized steel	10	10	10	10	10	10	10	10
Aluminum	10	10	10	10	10	10	10	10

O/N - Overnight (8-16 hrs)

* - Not tested due to very poor storage stability

Sol - Solidified
Coag - Coagulated

Appendix B-1 (Cont)

Formulated Primers

TEST DATA	F-1	F-2	F-3	F-4	F-5	F-7	F-8	TP-P-1757
<u>SALT FOG EXPOSURE</u>								
<u>Bonderized Steel</u>								
DFT - 1.0 mil	72	144	144	144	No	72	144	144
Blistering								
At X	6F	10	8M	8F	test	8F	6M	10
Overall	4F	8F	8M	8F		8F	6M	10
Corrosion								
At X	8	8	8	8		4	6	9
Overall	6	6	10	8		4	6	10
DFT - 1.5 mils	72	144	144	144		72	144	144
Blistering								
At X	10	10	8M	8F		8F	6F	10
Overall	4F	6F	8M	8F		8F	6F	10
Corrosion								
At X	8	9	8	8		6	8	9
Overall	8	8	10	9		6	8	10
<u>Aluminum</u>								
DFT - 1.0 mil	144	144	144	144		144	144	144
Blistering								
At X	10	10	8M	10		10	10	10
Overall	10	10	8M	10		10	10	10
Corrosion								
At X	10	10	10	10		10	10	10
Overall	10	10	10	10		10	10	10
DFT - 1.5 mils	144	144	144	144		144	144	144
Blistering								
At X	10	10	10	10		10	10	10
Overall	10	10	8F	10		10	10	10
Corrosion								
At X	10	10	10	10		10	10	10
Overall	10	10	10	10		10	10	10

Appendix B-1 (Cont)
Formulated Primers

TEST DATA

SALT FOG EXPOSURE

Bonderized Steel

	<u>F-9</u>	<u>F-10</u>	<u>F-11</u>	<u>F-12</u>	<u>F-13</u>	<u>F-14</u>	<u>F-15</u>	<u>F-16</u>
Hrs ASTM	<u>97</u>	<u>144</u>	<u>144</u>	<u>72</u>	<u>72</u>	<u>144</u>	<u>144</u>	<u>144</u>
DFT - 1.0 mil Blistering	8MD	10	8M	8M	8M	10	10	8F
At X	8M	6M	6F	8M	8M	6F	10	8F
Overall								
Corrosion								
At X	4	8	6	4	6	8	9	6
Overall	6	9	9	4	6	9	10	8

DFT - 1.5 mils
Blistering

Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>72</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
At X	8MD	10	10	8M	4M	10	10	10
Overall	8M	9MD	10	8M	4M	10	10	10
Corrosion								
At X	6	6	9	6	6	8	9	8
Overall	6	10	10	8	8	9	10	9

Aluminum

DFT - 1.0 mil
Blistering

Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
At X	10	10	10	10	10	10	10	10
Overall	10	9MD	10	10	10	10	10	10
Corrosion								
At X	10	10	10	10	10	10	10	10
Overall	10	10	10	10	10	10	10	10

DFT - 1.5 mils
Blistering

Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
At X	10	10	10	10	10	10	10	10
Overall	10	9MD	10	10	10	10	10	10
Corrosion								
At X	10	10	10	10	10	10	10	10
Overall	10	10	10	10	10	10	10	10

Appendix B-2
Submitted by Raw Materials Suppliers

TEST DATA

	<u>S-1</u>	<u>S-2</u>	<u>S-3</u>	<u>S-4</u>	<u>S-5</u>	<u>S-6</u>	<u>S-7</u>	<u>S-8</u>
VOC (as applied)	gm/l lbs/gal	131 1.1	308 2.6	294 2.5	326 2.7	127 1.1	264 2.2	56 0.5
Weight per Gallon	lbs	10.96	11.26	10.19	10.17	11.94	10.83	10.48
Total Solids	%	50.6	50.3	52.3	52.0	60.6	52.1	41.8
Flash Point	°F	150+	150+	150+	150+	150+	150+	120
Viscosity	KU							
Initial		75	136	141+	121	72	54	67
4 weeks at 125°F		141+	141+	141+	141+	85	55	71
Freeze-thaw	Coag	Coag	139	141+	134	Coag	Coag	68
Storage Stability	Score							
Liquid separation		8	8	6	8	6	8	6
Skimming		2	2	2	6	9	9	9
Pigment settling		10	9	9	9	8	2	9
Ease of remixing		8	8	6	9	8	2	9
Speed of Dry	Hrs							
Set to touch		0.1	0.2	0.1	0.1	0.1	0.2	0.3
Dry tack free		0.2	0.2	0.2	0.2	0.2	0.2	0.4
Dry hard		0.2	0.8	3.1	3.1	0.2	0.2	0.4
Dry thru		0.3	1.7	3.6	3.6	0.3	0.3	0.5
Sprayability	Score	10	10	10	10	10	10	10
Brushability	Score	10	9	6	6	10	10	9
Adhesion To -								
Bonderized Steel	Score	10	10	10	10	10	10	10
Aluminum	"	10	10	10	10	10	10	10

Appendix B-2 (Cont)
Submitted by Raw Material Suppliers

TEST DATA

SALT FOG EXPOSURE

Bonderized Steel

DFT - 1.0 mil
Blistering
At X
Overall
Corrosion
At X
Overall

DFT - 1.5 mils
Blistering
At X
Overall
Corrosion
At X
Overall

Aluminum

DFT - 1.0 mil
Blistering
At X
Overall
Corrosion
At X
Overall

DFT - 1.5 mils
Blistering
At X
Overall
Corrosion
At X
Overall

	<u>S-1</u>	<u>S-2</u>	<u>S-3</u>	<u>S-4</u>	<u>S-5</u>	<u>S-6</u>	<u>S-7</u>	<u>S-8</u>
Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>97</u>	<u>144</u>	<u>24</u>
Score	4F 4M 8 8	8M 8M 6 6	6M 6M 6 8	8M 8F 6 8	8F 6M 6 6	8M 8M 8 6	8M 8M 6 6	6F 6M 6 6
Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
Score	10 4M 8 8	8F 8F 8 10	6F 10 9 10	8F 8F 8 9	8F 4F 6 8	8D 8D 8 8	9M 9M 10 10	4M 2M 6 8
Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
Score	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	8F 8F 6 6	10 10 10 10
Hrs ASTM	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
Score	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10	10 10 10 10

Appendix B-3

Proprietary Primers

TEST DATA

	M-1	M-2	M-3	M-4	M-5*
VOC (as applied)	128 1.1	41 0.3	217 1.8	72 0.6	364 3.0
Weight per Gallon	10.81	12.04	10.75	11.48	10.23
Total Solids	54.9	62.4	51.1	72.6	52.7
Flash Point	150+	150+	150+	140	90/150
Viscosity					
Initial	55	83	92	91	91/141+
4 weeks at 125°F	86	74	74	141+	141/141+
Freeze-thaw	Coag	Coag	141+	92	92/***
Storage Stability					
Liquid separation	2	4	8	8	8/8
Skimming	10	10	9	9	9/6
Pigment settling	2	6	2	9	6/9
Ease of remixing	2	9	2	9	8/9
Speed of Dry					
Set to touch	0.2	0.2	0.2	**	0.2
Dry tack free	0.5	0.3	0.6		24+
Dry hard	0.6	0.3	0.8		24+
Dry thru	0.9	0.3	0.8		24+
Sprayability	10	10	10	10	10
Brushability	10	10	8	6	10
Adhesion To -					
Bonderized steel	10	10	10	10	10
Aluminum	10	10	10	10	10
Coag - Coagulated					

* Two component (Pot life = 24 + hrs)

** Very gritty - dropped

*** Insufficient to test

Appendix B-3 (Cont)

Proprietary Primers

TEST DATA

	M-6	M-7	M-8	M-9	M-10	M-11
VOC (as applied)	277 gm/l 2.3 lbs/gal	254 2.1	333 2.8	360 3.0	28 0.2	146 1.2
Weight per Gallon	10.70	10.63	10.01	11.02	10.34	9.97
Total Solids	50.2	47.1	45.7	60.5	55.1	38.5
Flash Point	120	150	130	94	150+	150+
Viscosity						
Initial	98	82	58	103	64	89
4 weeks at 125°F	Coag	Coag	95	117	72	92
Freeze-thaw	102	74	83	X	64	Coag
Storage Stability						
Liquid separation	4	2	6	9	8	8
Skinning	10	10	10	4	9	9
Pigment settling	10	10	10	9	9	9
Ease of remixing	0	0	8	9	9	9
Speed of Dry						
Set to touch	0.2	0.2	0.3	0.5	0.2	0.3
Dry tack free	0.3	0.3	0.8	O/N	0.2	0.4
Dry hard	0.8	2.0	1.0	O/N	0.3	0.4
Dry thru	1.7	2.0	1.0	O/N	0.5	0.5
Sprayability	10	10	10	10	10	10
Brushability	10	10	10	8	2	10
Adhesion To -						
Bonderized steel	10	10	10	10	10	10
Aluminum	10	10	10	10	10	10

Coag - Coagulated

O/N - Overnight (8-16 hrs)

X - Not applicable - solvent thinned

TEST DATA

SALT FOG EXPOSURE

Bonderized Steel

DFT - 1.0 mil
Blistering
At X
Overall
Corrosion
At X
Overall

Hrs
ASTM

Score

DFT - 1.5 mils
Blistering
At X
Overall
Corrosion
At X
Overall

Hrs
ASTM

Score

Aluminum

DFT - 1.0 mil
Blistering
At X
Overall
Corrosion
At X
Overall

Hrs
ASTM

Score

DFT - 1.5 mils
Blistering
At X
Overall
Corrosion
At X
Overall

Hrs
ASTM

Score

Appendix B-3 (Cont)

Proprietary Primers

	<u>M-1</u>	<u>M-2</u>	<u>M-3</u>	<u>M-4</u>	<u>M-5</u>	<u>TT-P-1757</u>
	<u>144</u>	<u>65</u>	<u>24</u>	No	<u>120</u>	<u>144</u>
	8F	8D	8F		2D	10
	6F	8D	8M	test	4D	10
	6	8	8		6	9
	6	9	4		8	10
	<u>144</u>	<u>144</u>	<u>24</u>		<u>120</u>	<u>144</u>
	8F	6F	10		2D	10
	8M	9D	8F		4D	10
	8	8	8		6	9
	8	10	6		8	10
	<u>144</u>	*	<u>144</u>		<u>144</u>	<u>140</u>
	10		10		10	10
	10		10		10	10
	10		10		10	10
	10		10		10	10
	<u>144</u>	*	<u>144</u>		<u>144</u>	<u>144</u>
	10		10		10	10
	10		10		10	10
	10		10		10	10
	10		10		10	10
	<u>144</u>		<u>144</u>		<u>144</u>	<u>144</u>
	10		10		10	10
	10		10		10	10
	10		10		10	10
	10		10		10	10

* Panels pitted due to pH of A.P.

Appendix B-3 (Cont.)
Proprietary Primers

TEST DATA

SALT FOG EXPOSURE

Bonderized Steel

	<u>M-6</u>	<u>M-7</u>	<u>M-8</u>	<u>M-9</u>	<u>M-10</u>	<u>M-11</u>
DFT - 1.0 mil						
Blistering	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>28</u>	<u>72</u>
At X						
Overall	8F	8F	8F	4M	10	6D
Corrosion	8F	8F	8F	6F	9M	6D
At X						
Overall	8	8	8	8	6	4
	10	10	8	9	8	4
DFT - 1.5 mils						
Blistering	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>28</u>	<u>98</u>
At X						
Overall	10	10	10	10	10	6MD
Corrosion	9F	9F	8F	10	8M	6MD
At X						
Overall	9	9	8	9	6	2
	10	10	9	10	8	2

Aluminum

DFT - 1.0 mil						
Blistering	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
At X						
Overall	10	10	10	10	8F	10
Corrosion	10	10	10	10	6M	8F
At X						
Overall	10	10	10	10	10	10
	10	10	10	10	10	10
DFT - 1.5 mils						
Blistering	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>	<u>144</u>
At X						
Overall	10	10	10	10	8F	10
Corrosion	10	10	10	10	6F	10
At X						
Overall	10	10	10	10	10	10
	10	10	10	10	10	10

Appendix C-1

FORMULATIONS

<u>No. F-1</u>	<u>Formulation FX-8</u>		<u>Buckman Laboratories</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Arolon 585	128.9	14.48	45
Butyl Cellosolve	19.9	2.65	52
Triton X-405	5.7	0.62	42
Water	49.3	5.91	-
Busperse 53	1.0	0.11	3
Ti-Pure R-900	165.9	4.85	15
Busan 11-M1	47.4	1.73	3
Attagel 50	9.5	0.48	17

Disperse on Cowles to 4-5 Heg.
Let Down With

Arolon 585	543.1	61.02	45
Water	21.8	2.62	-
Cobalt - 6%	1.9	0.26	48
Zirconium - 6%	<u>5.6</u>	<u>0.80</u>	48
Total	1000.0	95.53	

Weight per Gallon = 10.47 lbs

VOC = 101 gms/liter

0.8 lbs/gal

Appendix C-1

FORMULATIONS

No. F-2

Formulation P-1686-116-3

Cargill, Inc.

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Alkyd 7418	176.1	20.47	5
Ethylene Glycol			
Monobutyl Ether	70.4	9.37	52
Ammonium Hydroxide - 28%	12.5	1.66	-
Water	229.3	27.53	-
Atomite	87.6	3.88	49
Mistron Talc	58.5	2.54	9
1475 Red Oxide	92.9	2.32	40
Zinc Phosphate #317	77.8	2.87	40
Imsil A-10	19.5	0.88	26
Aerosil R-972	7.5	0.41	11
Ben-a-gel EW	2.2	0.11	34
Byk 301	0.9	0.11	4

Disperse on Pebble Mill
Let Down With

Alkyd 7418	44.2	5.14	5
Ammonium Hydroxide - 28%	1.9	0.25	-
Ethyl Glycol			
Monobutyl Ether	17.8	2.37	52
6% Cobalt Intercar	1.8	0.25	28
6% Zirconium Intercar	0.9	0.13	28
Activ - 8	0.9	0.11	53
Water	<u>97.3</u>	<u>11.68</u>	-
Total	1000.0	92.08	

Weight per Gallon = 10.86 lbs

VOC = 324 gms/liter

2.7 lbs/gal

Appendix C-1

FORMULATIONS

<u>No. F-3</u>	<u>Formulation 5727C</u>		<u>Halox Pigments</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water)	90.7	10.89	-
Kelsol 3921)	105.8	12.24	45
Triethylamine) Premix	5.6	0.60	52
EA-1075	21.6	3.13	34
Cobalt Hydrocure - 6%	1.9	0.25	33
Manganese Hydrocure - 6%	1.9	0.25	33
Halox BW-191	92.6	3.90	24
R-900	164.5	4.94	15
Lampblack #101	6.9	0.47	37

Disperse and Let Down With

Water	112.2	13.48	-
Butyl Cellosolve	25.9	3.47	52
Kelsol 3921)	181.3	20.99	45
Water) Premix	95.0	11.41	-
Triethylamine)	8.6	0.92	52
Water	60.4	7.25	-
Butyl Cellosolve	17.3	2.31	52

Adjust pH to 8.3 - 8.5 With

Water & Ammonium Hydroxide	<u>7.8</u>	<u>0.98</u>	-
Total	1000.0	97.48	

Weight per Gallon = 10.26 lbs

VOC = 348 gms/liter

2.9 lbs/gal

Appendix C-1

FORMULATIONS

<u>No. F-4</u>	<u>Formulation 7585D</u>		<u>Halox Pigments</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	83.7	10.04	-
Natrosol 250 MHR	0.8	0.07	25
Ammonium Hydroxide - 28%	1.1	0.14	-
Methyl Carbitol	54.3	7.23	52
QR-681M	21.0	2.33	42
CO-630	2.9	0.34	20
Surfynol 104E	4.5	1.05	1
R-900	54.3	1.63	15
Atomite	54.3	2.41	49
Halox BW-191	62.5	2.63	24
Kadox 515	5.4	0.12	23
Disperse and Let Down With			
Rhoplex MV-23	540.5	61.42	42
Texanol	5.8	0.73	16
Aroplaz 1271	55.7	6.66	45
Zirconium - 6%	3.4	0.47	48
Cobalt - 6%	0.3	0.04	48
Manganese - 6%	0.3	0.04	48
Foamaster VL	1.1	0.14	12
Skane M-8	2.2	0.25	42
Water	29.6	3.55	-
QR-708	16.3	1.82	42
Total	1000.0	103.11	

Weight per Gallon = 9.70 lbs

VOC = 216 gms/liter

1.8 lbs/gal

Appendix C-1

FORMULATIONS

No. F-5

Mineral Pigments

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	233.4	28.01	-
QP-1500	3.3	0.28	52
KTPP	0.9	0.09	46
Tamol 850	5.6	0.65	42
Ethylene Glycol	28.0	2.99	52
Dalpad A	11.2	1.21	22
Dibutyl Phthalate	7.5	0.84	52
Igepal 630	2.8	0.28	20
Nopco NXZ	1.9	0.28	12
Dowcil 75	1.4	0.09	13
R-900	140.1	4.20	15
Phos-Plus	93.4	3.55	10
Atomite	46.7	1.87	49

Disperse and Let Down With

UCAR 4358	329.5	38.10	52
Nopco NXZ	0.9	0.09	12
Water	<u>93.4</u>	<u>11.20</u>	-
Total	1000.0	93.73	

Weight per Gallon = 10.67

VOC = 216 gms/liter

1.8 lbs/gal

Appendix C-1

FORMULATIONS

<u>No. F-7</u>	<u>Formulation 137-68</u>		<u>PVO International</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	218.4	26.21	-
Igepal CO-630	4.7	0.38	20
KTPP	2.8	0.19	46
Natrosol 250 HR	2.8	0.19	25
J1310 Zinc Chromate	142.5	4.37	32
1400 Red Iron Oxide	23.8	0.57	37
Gold Bond R	189.9	8.64	47
Drew L-475	1.9	0.28	14
Disperse on Pebble Mill Let Down With			
CEE-5 Emulsion	<u>413.2</u>	<u>54.89</u>	39
Total	1000.0	95.72	

Weight per Gallon = 10.44 lbs

VOC = 6.2 gms/liter

0.1 lb/gal

Appendix C-1

FORMULATIONS

<u>No. F-8</u>	<u>Formulation PWB-76</u>		<u>Reichard-Coulston</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	112.0	13.44	-
Tamol 731	15.2	1.66	42
Triton CF-10	2.7	0.30	42
Foamaster G	1.8	0.23	12
Ethylene Glycol	25.1	2.68	52
Dowcil 75	0.5	0.04	13
551 Lecithin	1.8	0.20	43
Cellosize QP-4400	1.3	0.12	52
3097 Red Oxide	89.6	2.19	37
317 Zinc Phosphate	31.3	1.16	40
325 Mesh W.G. Mica	29.6	1.26	18
Atomite	179.1	7.93	49
J1310 Zinc Yellow	4.5	0.15	32

Disperse and Let Down With

Arolon X820	433.4	49.26	45
Foamaster G	0.9	0.12	12
Butyl Carbitol	5.4	0.68	52
Butyl Carbitol Acetate	5.4	0.66	52
Aroplaz 1271	22.4	2.68	45
Triton CF-10	1.3	0.14	42
Water	31.3	3.76	-
Ammonium Hydroxide - 28%	5.4	0.72	-
Total	1000.0	89.38	

Weight per Gallon = 11.19 lbs

VOC = 159 gms/liter

1.3 lbs/gal

Appendix C-1

FORMULATIONS

<u>No. F-9</u>	<u>Formulation KK-1006-7A</u>	<u>Reichard-Coulston</u>	
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Titanox 2020	84.1	2.47	34
Mapico Black	2.5	0.06	8
ASP-100	59.3	2.77	17
Atomite	59.3	2.64	49
Moly White 212	49.4	1.98	44
38-690 Epotuf	168.1	19.98	41
Disperse and Let Down With			
38-690 Epotuf	192.8	22.94	41
Triethylamine	16.8	2.76	52
6% Cobalt Napthenate	1.7	0.21	48
4% Calcium Napthenate	9.9	1.32	48
Troykyd LLBA	19.8	2.23	50
Mix Well and Add			
Water	<u>336.3</u>	<u>40.37</u>	-
Total	1000.0	99.73	

Weight per Gallon = 10.03 lbs

VOC = 324 gms/liter

2.7 lbs/gal

Appendix C-1

FORMULATIONS

No. F-10

Formulation 1855-32A

Spencer Kellogg

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	202.9	24.35	-
Ammonium Hydroxide - 28%	8.2	1.08	-
Kelsol 3906	101.3	11.78	45
Butyl Cellosolve	10.1	1.35	52
Cobalt Nuocure - 6%	4.1	0.52	33
Manganese Nuocure - 6%	4.1	0.54	33
Activ - 8	1.5	0.19	53
Sparmite Barytes	76.0	2.05	37
Halox SW-111	71.1	2.99	24
Mapico 297	50.8	1.18	8
Atomite	45.7	2.03	49
399 Talc	25.4	1.13	54

Disperse on Pebble Mill
Let Down With

Water	202.9	24.36	-
Ammonium Hydroxide - 28%	8.2	1.08	-
Kelsol 3906	177.6	20.65	45
Butyl Cellosolve	<u>10.1</u>	<u>1.35</u>	52
Total	1000.0	96.63	

Weight per Gallon = 10.35 lbs

VOC = 258 gms/liter

2.2 lbs/gal

Appendix C-1

FORMULATIONS

No. F-11

Formulation 2007-10-1

Spencer Kellogg

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	135.4	16.19	-
Triethylamine	5.4	0.89	52
Kelsol 3920	71.9	8.36	45
R-902	71.9	2.10	15
Raven Black 1020	0.9	0.06	8
Barytes W-1430F	89.9	2.44	37
Talc 399	80.9	3.60	54
Zinc Phosphate 317	44.9	1.72	40
Butyl Cellosolve	15.3	2.03	52
Butyl Carbitol	9.9	1.25	52
Patcote 531	0.4	0.06	36

Disperse on Pebble Mill to 6 Heg.
Let Down With

Kelsol 3920	170.7	19.86	45
Aroplaz 1272	19.8	2.36	45
Ammonium Hydroxide - 28%	9.0	1.20	-
Cobalt Hydrocure - 6%	1.8	0.23	33
Manganese Hydrocure - 6%	1.8	0.23	33
Exkin #2	0.4	0.06	48
Water	<u>269.7</u>	<u>32.37</u>	-
Total	1000.0	95.01	

Weight per Gallon = 10.52 lbs

VOC = 252 gms/liter

2.1 lbs/gal

Appendix C-1

FORMULATIONS

No. F-12

Formulation RM-3

Wet Ground Mica Ass

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Cellosize QP-4400 - 2.5%	71.6	8.52	52
Ethylene Glycol	17.8	1.90	52
Tamol 731	8.0	0.87	42
Triton CF-10	1.8	0.20	42
Nopco NXZ	1.8	0.27	12
TiPure R-900	170.8	5.13	15
Atomite	81.9	3.63	49
Moly White 212	46.0	1.84	44
325 Mesh W.G. Mica	40.4	1.72	18
Kadox 15	4.9	0.10	23

Disperse and Let Down With

Water	62.5	7.51	-
Rhoplex MV-23	485.1	50.02	42
Tri-butyl phosphate	4.0	0.49	52
Nopco NXZ	1.8	0.27	12
Merbac 35	1.6	0.14	31
Total	1000.0	82.61	

Weight per Gallon = 12.11 lbs

VOC = 85 gms/liter

0.7 lb/gal

Appendix C-1

FORMULATIONS

No. F-13

Formulation RN-3

Wet Ground Mica Ass.

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Bentone LT - 2.5%	146.1	17.14	34
Ethylene Glycol	20.1	2.15	52
Tamol 850	4.6	0.47	42
Triton X-100	2.3	0.26	42
Nopco NXZ	0.9	0.14	12
TiPure R-900	91.3	2.74	15
Gold Bond R	91.3	4.14	47
325 Mesh W.G. Mica	45.6	1.94	18
Nalzin SC-1	41.1	1.21	34
Atomite	27.4	1.21	49

Disperse and Let Down With

Water	16.4	1.97	-
Rhoplex MV-23	502.1	51.76	42
Tamol 850	4.5	0.47	42
Tributyl Phosphate	4.5	0.56	52
Nopco NXZ	0.9	0.13	12
Merbac 35	0.9	0.07	31
Total	1000.0	86.36	

Weight per Gallon = 11.58 lbs

VOC = 80 gms/liter

0.7 lb/gal

Appendix C-1

FORMULATIONS

No. F-14

Formulation 30708-2

Celanese Chemical

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Celanese 30708-2	99.7	11.85	6
Triton X-405	7.7	0.83	42
Water	85.2	10.22	-
Ammonium Hydroxide - 28%	6.6	0.89	-
Busperse 53	1.3	0.16	3
R-900	223.6	6.54	15
Busan 11 M-1	63.9	2.33	3
Attagel 50	12.8	0.65	17

Disperse to 4-5 Heg.
Let Down With

Celanese 30708	419.8	49.92	6
Butyl Cellosolve	26.8	3.57	52
NuXtra Manganese - 6%	12.8	1.71	48
NuXtra Cobalt - 6%	12.8	1.74	48
NuXtra Zirconium - 6%	12.8	1.78	48
Ammonium Hydroxide - 28%	<u>14.2</u>	<u>1.89</u>	-
Total	1000.0	94.08	

Weight per Gallon = 10.63 lbs

VOC = 300 gms/liter

2.5 lbs/gal

Appendix C-1

FORMULATIONS

<u>No. F-15</u>	<u>Formulation 30708-3</u>		<u>Celanese Chemical</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Celanese 30708-3	99.0	11.77	6
Triton X-405	7.6	0.83	42
Water	84.6	10.16	-
Ammonium Hydroxide - 28%	8.5	1.13	-
Busperse 53	1.3	0.16	3
R-900	222.2	6.50	15
Busan 11 M-1	63.5	2.31	3
Attagel 50	12.7	0.64	17
Disperse to 4-5 Heg. Let Down With			
Celanese 30708	417.1	49.60	6
Butyl Cellosolve	26.7	3.55	52
NuXtra Manganese - 6%	12.7	1.70	48
NuXtra Cobalt - 6%	12.7	1.73	48
NuXtra Zirconium - 6%	12.7	1.77	48
Ammonium Hydroxide - 28%	18.7	2.51	-
Total	1000.0	94.36	

Weight per Gallon = 10.60 lbs

VOC = 300 gms/liter

2.5 lbs/gal

Appendix C-1

FORMULATIONS

No. F-16

Formulation 30708-4

Celanese Chemical

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Celanese 30708-4	99.8	11.86	6
Triton X-405	7.7	0.84	42
Water	85.3	10.23	-
Ammonium Hydroxide - 28%	16.1	2.15	-
Busperse 53	1.3	0.16	3
R-900	223.8	6.55	15
Busan 11 M-1	64.0	2.33	3
Attagel 50	12.8	0.65	17

Disperse to 4-5 Heg.
Let Down With

Celanese 30708	420.1	49.97	6
Butyl Cellosolve	26.9	3.57	52
NuXtra Manganese - 6%	12.8	1.71	48
NuXtra Cobalt - 6%	12.8	1.74	48
NuXtra Zirconium - 6%	12.8	1.78	48
Ammonium Hydroxide - 28%	<u>3.8</u>	<u>0.51</u>	-
Total	1000.0	94.05	

Weight per Gallon = 10.63 lbs

VOC = 300 gms/liter

2.5 lbs/gal

Appendix C-2

FORMULATIONS

No. S-1

Formulation CAS 1795

Rohm & Haas Co.

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Butyl Cellosolve	41.8	5.49	52
Water	124.6	14.93	-
Dee Fo 806-102	1.0	0.13	51
Igepal CTA-639	3.1	0.38	20
Tamol 165	13.5	1.69	42
Red Iron Oxide RO-8097	75.0	1.77	37
Busan 11 M-1	62.2	2.26	3
499 Talc	77.1	3.43	29
290 Barytes Lo-Micron	108.2	2.88	54

Disperse to 7 Heg.
Let Down With

Rhoplex WL-91	381.9	44.43	42
Triton X-405	9.0	1.01	42
Butyl Carbitol	23.8	2.99	52
Dibutyl Phthalate	15.8	1.80	52
Butyl Cellosolve	37.8	5.03	52
Ammonium Hydroxide - 14%	6.2	0.75	-
Ammonium Benzoate - 10%	19.0	2.29	-
Total	1000.0	91.20	

Weight per Gallon = 10.96 lbs

VOC = 284 gms/liter

2.4 lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-2</u>	<u>Formulation ESA-1136</u>		<u>Rohm & Haas Co.</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	54.5	6.54	-
Methyl Carbitol	54.5	6.32	52
QR-681M	19.5	2.13	42
Amp-95	2.9	0.35	2
Triton CF-10	2.9	0.33	42
Drew L-405	2.7	0.39	14
Kadox 515	6.8	0.15	23
Red Oxide RO-8097	53.5	1.31	37
Atomite	81.1	3.58	49
Nalzin SC-1	77.8	2.31	34
Disperse and Let Down With			
Rhoplex MV-23	576.0	65.65	42
Texanol	6.2	0.79	16
Aroplaz 1271 & Driers*	29.2	3.49	-
Sodium Nitrite - 13.8%	7.8	0.93	-
Skane M-8	2.0	0.22	42
Drew L-493	3.3	0.48	14
QR-708	6.8	0.76	42
Water	<u>12.5</u>	<u>1.51</u>	-
Total	1000.0	97.25	
* Aroplaz 1271	93.4%)		45
6% Cobalt Napthenate	0.5%)		48
6% Manganese Napthenate	0.5%)	Premix	48
6% Zirconium Napthenate	5.6%)		48

Weight per Gallon = 10.28 lbs

VOC = 131 gms/liter

1.1 lbs/gal

Appendix C-2

FORMULATIONS

No. S-3

Formulation ESA-1252-3

Rohm & Haas Co.

	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	37.9	4.54	-
Methyl Carbitol	55.2	6.40	52
QR-681M	24.5	2.68	42
Amp-95	3.0	0.35	2
Triton CF-10	3.0	0.34	42
Dreq L-405	2.8	0.39	14
Kadox 515	6.7	0.15	23
Red Oxide RO-8097	54.2	1.33	37
Atomite	74.3	3.29	49
Halox BW-191	78.8	3.32	24

Disperse and Let Down With

Water	17.0	2.05	-
Rhoplex MV-23	551.0	52.98	42
Texanol	5.9	0.75	16
Aroplaz 1271 + Driers*	60.1	7.19	-
Sodium Nitrite - 13.8%	7.9	0.95	-
Drew L-493	3.3	0.48	14
QR-708	14.4	1.61	42
Total	1000.0	88.8	

* Aroplaz 1271	93.4%)	45
6% Cobalt Napthenate	0.5%)	48
6% Manganese Napthenate	0.5%)	48
6% Zirconium Napthenate	5.6%)	48

Premix

Weight per Gallon = 11.26 lbs

VOC = 308 gms/liter

2.6 lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-4</u>	<u>Formulation ESA-1255-1</u>		<u>Rohm & Haas Co.</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	37.5	4.51	-
Methyl Carbitol	54.8	6.35	52
QR-681M	24.3	2.67	42
Amp-95	2.9	0.35	2
Triton CF-10	2.9	0.33	42
Drew L-405	2.7	0.39	14
Kadox 515	6.7	0.15	23
Red Oxide RO-8097	53.8	1.32	37
Atomite	81.0	3.59	49
Zinc Phosphate #317	78.2	2.88	40
Disperse and Let Down With			
Water	16.9	2.42	-
Rhoplex MV-23	547.0	62.32	42
Texanol	5.9	0.74	16
Aroplaz 1271 + Driers*	60.0	7.14	-
Sodium Nitrite - 13.8%	7.8	0.94	-
Drew L-493	3.3	0.48	14
QR-708	14.3	1.58	42
Total	1000.0	98.16	
* Aroplaz 1271	93.4%)		45
6% Cobalt Napthenate	0.5%)		48
6% Manganese Napthenate	0.5%)	Premix	48
6% Zirconium Napthenate	5.6%)		48

Weight per Gallon = 10.19 lbs

VOC = 294 gms/liter

2.5 lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-5</u>	<u>Formulation FL-2915</u>		<u>Rohm & Haas Co.</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	37.9	4.54	-
Methyl Carbitol	55.2	6.40	52
QR-681M	24.5	2.69	42
Amp-95	3.0	0.35	2
Triton CF-10	3.0	0.34	42
Drew L-405	2.7	0.39	14
Kadox 515	6.7	0.15	23
Red Oxide RO-8097	54.2	1.33	37
Atomite	76.5	3.39	49
MolyWhite 212	78.8	3.13	44
Disperse and Let Down With			
Water	17.0	2.05	-
Rhoplex MV-23	551.1	62.83	42
Texanol	5.9	0.75	16
Aroplaz 1271 + Driers*	60.1	7.20	-
Sodium Nitrite - 13.8%	7.9	0.95	-
Drew L-493	3.4	0.48	14
QR-708	<u>12.1</u>	<u>1.35</u>	42
Total	1000.0	98.32	
* Aroplaz 1271	93.4%)		45
6% Cobalt Napthenate	0.5%)		48
6% Manganese Napthenate	0.5%) Premix		48
6% Zirconium Napthenate	5.6%)		48

Weight per Gallon = 10.17 lbs

VOC = 326 gms/liter

2.7 lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-6</u>		<u>Formulation No. P-21</u>		<u>ICI Americas</u>
		<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	)	39.0	4.68	-
Colloids 642	)	1.0	0.14	7
Methocel J12-MS-2.5%	) Premix	80.0	9.60	13
Pluronic F-87-30%	)	7.0	0.83	30
Zinc Phosphate 317		57.0	2.10	40
Barytes No. 1		163.0	4.45	37
Red Oxide RC 1475		26.0	0.65	40
Colloids 642		1.0	0.14	7
Disperse to 4-5 Heg. Let Down With				
Haloflex 202		592.0	55.33	35
Ammonia (28%) - to pH4		-	-	-
Then add				
Pluronic F-87-30%		24.0	2.85	30
Texanol		<u>10.0</u>	<u>1.27</u>	16
Total		1000.0	82.04	

Weight per Gallon = 12.19 lbs

VOC = gms/liter
lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-7</u>	<u>Formulation 191</u>		<u>Polyvinyl Chemical</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
NeoCryl A-622	334.5	39.21	38
Tamol SG-1	10.5	1.10	42
Triton CF-10	3.7	0.42	42
Colloid 643	2.2	0.31	7
Zopaque RCL-9	70.6	2.07	21
Yellow Iron Oxide 22880	47.0	1.40	37
Zinc Phosphate #317	45.2	1.73	40
Nytal 400	89.2	3.75	53
Atomite	64.8	2.88	49
Disperse and Let Down With			
NeoCryl A-622	147.5	17.30	38
Water	115.8	13.88	-
Premix and Add			
Epotuf 38-690	55.5	6.60	41
Ammonium Hydroxide - 28%	6.9	0.92	-
Add			
Ammonium Benzoate - 10%	<u>6.6</u>	<u>0.78</u>	-
Total	1000.0	92.35	

Weight per Gallon = 10.83 lbs

VOC = 264 gms/liter

2.2 lbs/gal

Appendix C-2

FORMULATIONS

<u>No. S-8</u>	<u>Formulation 14JG-74A</u>		<u>Union Carbide</u>
	<u>Lbs</u>	<u>Gals</u>	<u>Supplier</u>
Water	242.1	29.07	-
Cellosize QP-15000	3.9	0.34	52
KTPP	1.0	0.10	46
Tamol 850	5.9	0.68	42
Ethylene Glycol	29.3	3.12	52
Dalpad A	11.7	1.27	22
Dibutyl Phthalate	7.8	0.88	52
Igepal CO-630	2.9	0.29	20
Drew XPD-11-043-2	9.7	0.98	14
Balab 748	2.0	0.26	55
Dowcil 75	1.5	0.10	13
TiPure R-960	146.4	4.39	15
Nalzin SC-1	97.6	2.93	34
Disperse and Let Down With			
UCAR 4358	344.5	39.75	52
Balab 748	1.0	0.13	55
Water	<u>92.7</u>	<u>11.14</u>	-
Total	1000.0	95.43	

Weight per Gallon = 10.48 lbs

VOC = 56 gms/liter

0.5 lb/gal

Appendix C-3

FORMULATIONS

Sources of Raw Materials

1. Air Products & Chemicals
2. Angus Chemical Corp.
3. Buckman Laboratories
4. Byk Mallinkrodt
5. Cargill, Inc.
6. Celanese Polymer Specialities Co.
7. Colloids, Inc.
8. Columbian Chemical Co.
9. Cyprus Industrial Minerals
10. Frank D. Davis Co.
11. Degussa Corp.
12. Diamond Shamrock Corp.
13. Dow Chemical Corp.
14. Drew Chemical Corp.
15. E.I. duPont de Nemours & Co.
16. Eastman Chemical Products
17. Engelhard Minerals & Chemicals Corp.
18. English Mica Co.
19. Exxon, USA
20. GAF Corporation
21. Glidden & Durkee Division of SCM Corp.
22. W.R. Grace & Co.
23. G&W Natural Resources Group
24. Hammond Lead Products
25. Hercules, Inc.
26. Illinois Minerals Co.
27. International Minerals & Chemical Corp.
28. Interstab Chemicals, Inc.
29. Johns-Mansville Sales Corp.
30. BASF Wyandotte Corp.
31. Merck & Co.
32. Mineral Pigments Corp.
33. Mooney Chemicals, Inc.
34. NL Industries
35. ICI Americas, Inc.
36. C.J. Patterson Co.
37. Pfizer Corp.
38. Polyvinyl Chemical Industries
39. PVO International, Inc.

Appendix C-3

FORMULATIONS

Sources of Raw Materials

- 40. Reichard Coulston, Inc.
- 41. Reichhold Chemicals, Inc.
- 42. Rohm & Haas Co.
- 43. Ross & Rowe, Inc.
- 44. The Sherwin-Williams Co.
- 45. Spencer Kellogg, Division of Textron, Inc.
- 46. Stauffer Chemical Co.
- 47. Tammsco, Inc.
- 48. Tenneco Chemicals, Inc.
- 49. Thompson, Weinman & Co.
- 50. Troy Chemicals, Inc.
- 51. Ultra Adhesives, Inc.
- 52. Union Carbide Corporation
- 53. R.T. Vanderbilt Co.
- 54. Whittaker, Clark & Daniels, Inc.
- 55. Witco Chemical Corp.

Appendix D

Sources of Formulations or Primers

<u>Company</u>	<u>Contact</u>	<u>Sample No.</u>
Advanced Coatings & Chemicals 4343 Temple City Blvd Temple City, CA 91780		M-9 M-10
Buckman Laboratories, Inc. 1256 North McClean Blvd. Memphis, TN 38108	K.A. Haagenon Industry Specialist - Paint & Plastics	F-1
Cargill Research Dept. P.O. Box 9300 Minneapolis, MN 55440	A. Heitkamp Coatings Technology Service Laboratory	F-2
Celanese Chemicals & Specialties Co. 1065 West Hill Street P.O. Box 8248 Louisville, KY 40208	C.F. Dukes Business Manager - Coatings	F-14 F-15 F-16
DeVoe Marine Coatings Co. P.O. Box 7600 Louisville, KY 40207	V.J. Datta Product Line Manager	M-2 M-3 M-4 M-5
Fuller-O'Brien Division The O'Brien Corporation 450 East Grand Avenue South San Francisco, CA 94080	J. Lansingh Product Manager Metal Finishes	M-1
General Electric Co. Engineered Materials Group 305 Eastern Avenue Chelsea, MA 02150	J.M. Kelley Technical Service Specialist	M-8
Halox Pigments 1910 Cochran Road Pittsburgh, PA 15220	W.C. Spangenberg Vice President and General Manager	F-3 F-4

Appendix D (Cont)

Sources of Formulations or Primers

<u>Company</u>	<u>Contact</u>	<u>Sample No.</u>
ICI Americas Specialty Chemicals Div. P.O. Box 751 New Murphy Rd & Concord Pike Wilmington, DE 19897	W.P. Long Development Manager Product Development Dept.	S-6
Mineral Pigments Corp. 7011 Muirkirk Road Beltsville, MD 20705	M. Kaplan Technical Director	F-5
PVO International, Inc. 1145 South Tenth Street Richmond, CA 94804		F-7
Polyvinyl Chemical Industries 730 Main Street Wilmington, MA 01887	J.E. Fitzwater Technical Service Supervisor Coatings Products	S-7
Reichard-Coulston, Inc. 15 East 26th Street New York, NY 10010	C.W. Fuller	F-8 F-9
Rohm and Haas Co. Independence Mall West Philadelphia, PA 19105	D.M. Watson Market Manager Maintenance & Marine Coatings Polymers, Resins and Monomers	S-1 S-2 S-3 S-4 S-5
Sherwin Williams Co. A.W. Steudel Technical Center 549 East 115th Street Chicago, IL 60628	B. Delventhal Paint Chemist	M-6 M-7
Spencer Kellogg Div. of Textron, Inc. P.O. Box 210 4201 Genesee Street Buffalo, NY 14225	Dr. A. Ross Vice President, Research	F-10 F-11

Appendix D (Cont)

Sources of Formulations or Primers

<u>Company</u>	<u>Contact</u>	<u>Sample No</u>
Stanchem, Inc. 401 Berlin Street East Berlin, CT 06023	F.E. Flood Technical Director	M-11
Union Carbide Corp. Performance Chemicals & Polymers Division Garland, TX 75041	R.C. Pierrehumbert Senior Technical Specialist	S-8
Wet Ground Mica Association 60 Rock Harbor Road Orleans, MA 02653	Arnold J. Eickhoff Consultant	F-12 F-13

Appendix E
TEST PROCEDURE

Test methods developed by the American Society for Testing and Materials (ASTM) were used where possible.

1. Volatile Organic Compounds (VOC) Unit-gms/liter
or lbs/gal.

ASTM D-3960 "VOC of Paints and Related Coatings"

2. Weight per Gallon Unit - lbs

ASTM D-1475 "Density of Paint, Varnish, Lacquer and
Related Products"

3. Total Solids Unit - %

ASTM D-2832 "Nonvolatile Content of Paint and Paint
Materials"

4. Flash Point Unit - °F

ASTM D-93 "Flash Point by Pensky-Martens Closed Tester"

5. Viscosity Unit - KU

ASTM D-562 "Consistency of Paints Using the Stormer
Viscometer"

- a) Heat Storage - 4 weeks at 125°F

ASTM D-1849 "Package Stability of Paint"

- b) Freeze-thaw

ASTM D-2243 "Freeze-Thaw Resistance of Latex and
Emulsion Paints"

6. Storage Stability Unit - Score

ASTM D-1849 "Package Stability of Paint"

7. Drying Time Unit - Hrs

ASTM D-1640 "Drying, Curing or Film Formation of
Organic Coatings at Room Temperature"

8. Sprayability Unit - Score*

Federal Standard TT-P-141B, Method 2141 "Application
of Brushed Films"

9. Brushability Unit - Score*

Federal Standard TT-P-141B, Method 2141 "Application of Brushed Films"

10. Adhesion Unit - Score*

Federal Standard TT-P-141B, Method 6304 "Knife Test (Brittleness)"

11. Salt Fog Exposure

ASTM B-117 "Salt Spray (Fog) Testing"

a) Blistering Unit - See below

ASTM D-714 "Evaluating Degree of Blistering of Paints"

<u>Size</u>			<u>Concentration</u>		
9	-	Very Small	F	-	Few
8	-	Small	M	-	Medium
6	-	Medium	D	-	Dense
4	-	Large			
2	-	Very large			

b) Corrosion Unit - Score*

* Use ASTM Scoring Scheme as follows:

<u>Score</u>	<u>Performance</u>	or	<u>Effect</u>
10	Perfect		None
9	Excellent		Trace
8	Very good		Very slight
6	Good		Slight
4	Fair		Moderate
2	Poor		Considerable
1	Very poor		Severe
0	No value		Failed

Appendix F
CODE AND ABBREVIATIONS

A	-	Acceptable
ASTM	-	American Society for Testing and Materials test method
At X	-	At score mark cut thru the coating to expose the metal substrate
Dft	-	Dry film thickness
F	-	Failed
Gals	-	Gallons
gms/l	-	Grams per liter
hrs	-	Hours
KU	-	Krebs units
lbs/gal	-	Pounds per gallon
M	-	Marginal
Max.	-	Maximum
VOC	-	Volatile organic compounds
X	-	Not tested
xx	-	Minor property
%	-	Percent
°F	-	Degrees fahrenheit