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EXECUTIVE SUMMARY

EVALUATION OF ARCHITECTURAL COATINGS II

PART B

EXEMPT ARCHITECTURAL COATINGS

Contract # AO-075-31

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ABSTRACT

An important source of air pollution is the evaporation of solvent during the application of most paints and coatings. Consequently, the California Air Resources Board (CARB) has established specific limitations on the amount of volatile organic compounds (VOC), or solvents, employed in certain types of architectural coatings. However, because the low solvent technology had not fully developed, fourteen classes of architectural paints were exempted. These included the following:

1. Clear finishes, e.g., varnish
2. Semi-transparent wood stains
3. Opaque wood stains
4. Primers, sealers and undercoaters
5. Wood preservatives
6. Fire retardant paints
7. Tile-like glaze coatings
8. Waterproofing coatings
9. Maintenance paints
10. Metallic, e.g., aluminum paints
11. Swimming pool paints
12. Graphic art, e.g., sign paints
13. Mastic (thick) coatings
14. Multicolor (speckled) paints.

The ARB wished to determine whether products, among these exempt classes, were available on the market which would meet the VOC limitations and be competitive in performance to conventional, solvent-thinned, paints. Therefore, the ARB sponsored a study in 1979, performed by D/L Laboratories, to test architectural coatings among the exempt categories. The results were published in August 1980. A total of 89 low solvent and 57 conventional architectural coatings representing eleven of the fourteen exempt categories were tested at that time. Samples were submitted by coating manufacturers throughout the country in response to direct mail solicitation and notices in major trade publications. Samples received too late for inclusion in the initial evaluation were tested in this current follow-up study to determine the effect of additional testing on the original conclusions. An additional 20 low solvent and six conventional coatings were tested and expands the number of exempt categories for which coatings have been tested to twelve.

Samples could not be obtained for wood preservatives and sign paints. Upon closer examination, it was found that the fourteen classes were so broad in scope that they had to be expanded to a total of 26 classes and sub-classes, of which 24 were tested. The result of both the original and the current testing programs are compiled in this report and the original conclusions have been updated to reflect the additional data.

Results of laboratory tests and accelerated laboratory exposures demonstrate that a total of 42 low VOC coatings representing 8 of 12 classes tested and 13 of 24 sub-classes tested have the potential of competing with their equivalent conventional coatings. 9 of these sub-classes appear to be capable of being produced with VOC levels below 250 g/l. However, most are still not directly competitive with conventional coatings below that VOC level.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

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I SUMMARY AND CONCLUSIONS

This investigation is a continuation of a study, which was initiated in 1979, to evaluate low solvent architectural paints and coatings among the fourteen classes of products presently exempt from the California ARB Model Rule for Architectural Coatings. These products were to be compared with equivalent conventional (solvent-thinned) paints and coatings, preferably from the same suppliers, in order to determine whether each CARB conforming class, as a whole, was competitive with the equivalent conventional products and therefore can be removed from the exempt list.

Publicity releases were sent to 23 industry publications and industry associations during the inception of the program in order to reach as broad a source as possible. Ultimately, over 500 letters and questionnaire forms were sent to paint manufacturers and raw material suppliers throughout the United States. A total of 89 CARB conforming paints and coatings and 57 equivalent conventional coatings representing ten of the fourteen exempt classes were received before the cutoff date and tested in the first evaluation. The results were published in August 1980. Samples received too late for inclusion in the initial evaluation were tested in this current follow-up evaluation to determine the effect of additional testing on the original conclusions. The results of both evaluations are compiled in this report and the original conclusions have been revised to reflect the additional data.

Upon review of the samples and data received, it was evident that some of the exempt classes were too broad in scope and therefore had to be subdivided into sub-classes. The entire list of classes and sub-classes is shown in Table 1 below.

The evaluation was carried out using laboratory test methods and accelerated exposures commonly used in the industry. The properties evaluated were limited to those of major importance for each class in consideration of the time required for completion. The results of the tests were then summarized using a simple rating scheme of 10 to 0 in order to enable analysis of the data without the necessity of having a coating technology background.

The test coatings (both low-solvent and conventional) are compared to a standard representing a minimum acceptable level of performance. Low VOC coatings among the following exempt classes and sub-classes can be considered to be Acceptable and capable of competing with their conventional counterparts though some improvements can still be made. The average VOC levels are based on the data obtained and do not apply to all samples.

The conclusions apply to low VOC coatings tested as compared with the equivalent conventional coatings.

Class 1A Clear Interior Gloss Finishes

4 of the 5 coatings tested are equal to conventional clear interior gloss finishes in all properties tested. However the average VOC is 329 g/l.

Class 1B Clear Interior Semigloss Finishes

All 4 coatings tested are equal to conventional coatings clear interior semigloss finishes in all properties. The average VOC is 292 g/l.

Class 1C Clear Exterior Gloss Finishes

2 of the 3 coatings tested are equal to conventional clear exterior gloss finishes in performance but viscosity stability could be improved. The average VOC is 275 g/l.

Class 2 Transparent Stains

The 2 stains tested dry very well but they are not as transparent as desired and water repellancy could be improved. The average VOC is 121 g/l.

Class 3 Opaque Stains

2 of the 8 stains tested are almost equal to conventional opaque stains but 5 others could be improved in opacity and water repellancy. Average VOC is 119 g/l.

Class 4A-1 Metal Primers - One Package

2 of 13 primers tested exhibit superior stability and corrosion resistance but dry and opacity could be improved. Average VOC is only 44 g/l.

Class 4A-Z Metal Primers - Zinc Rich

2 of 3 primers tested are superior to conventional Zinc Rich primers, especially in durability. Average VOC is only 61 g/l.

Class 4B Exterior Wood Primers

3 of 5 primers tested are superior to conventional exterior wood primers except for less bleeding resistance, since most wood compounds which cause bleeding are water soluble. VOC averages 126 g/l.

Class 4C Interior Wall Primers

All 5 primers tested are competitive but will not seal water soluble stains as well. Average VOC is 100 g/l.

Class 7 Tile-Like Glaze Coatings

2 of the 6 coatings tested exhibit superior gloss and color retention as well as water resistance as compared with the conventional coatings. However their pot life and dry could be improved. Average VOC is 220 g/l.

Class 9A Maintenance Topcoats - Light Duty

4 of the 7 coatings tested exhibit faster dry and better weathering than the conventional topcoats but at a sacrifice in opacity. VOC averages 235 g/l.

Class 10 Metallic Paints

The two paints tested have possibilities but need improved storage stability and weathering. They would be satisfactory for interior use. No data on VOC was available.

Class 13B Mastic Coatings - Texture Paints

All 4 coatings tested are competitive to the conventional paints exhibiting better storage stability, faster dry and easier application. VOC averages only 26 g/l.

All other products tested are either not acceptable or insufficient in number to arrive at any conclusion.

II RECOMMENDATIONS

It is apparent from the results of this evaluation that products in the exempt list which readily meet the CARB VOC limit of 250 grams per liter of paint, less water, are limited.

However, it is evident that the requirement for low VOC concentration, is a technology that is becoming more attainable by the paint and coatings industry. Furthermore, Government agencies which use paints and coatings, such as the Army, Navy and Federal Highway Administration, are considering the specification of low VOC coatings. Therefore, there is an accelerating development of this technology.

Consequently, it is probable that, if a program such as the one covered in this report were repeated, the number of conforming products would be much greater. Paint manufacturers will have had more technological experience so that there should be more low VOC products readily available in the market place.

It also has been noted that many water based coatings tend to exhibit shorter periods of storage stability than conventional coatings. Therefore, it is possible that repeat tests, conducted on fresh samples, will yield improved results. It also is possible that low VOC coatings may exhibit improved performance if the applied coatings are allowable to cure for a longer period of time, approaching actual use conditions, e.g., one month rather than one week. Therefore, it may be advisable to repeat some tests after longer periods of drying. Of course, this will have to be done in comparison with equivalent aged conventional coatings to avoid drawing conclusions based on one sided test data.

An additional test of major importance is the field exposure testing of exterior paints. Although laboratory accelerated exposures are conducted for the sake of expediency when testing new products, exterior paints should also be subjected to actual exposure outdoors. There are a number of exposure stations, located primarily in Florida, as well as in other locations, such as Arizona, with a high level of sunlight, and Puerto Rico with a climate having both a high level of sunlight plus high humidity which accelerates the growth of mildew. Results of tests conducted at these stations are accepted by the trade. However at least a year of exposure, and preferably two years of exposure, are required for meaningful results.

III INTRODUCTION

Architectural coatings are a significant source of air pollution, inasmuch as approximately one half of each gallon of paint, varnish, lacquer or related coating consists of volatile solvents which evaporate when the coating is applied. This is a relatively minor problem with water-base coatings, in which most of the solvent is water, but is serious with solvent-thinned coatings. The solvents emitted during application of the latter pollute the air in the immediate vicinity and eventually spread elsewhere.

California was foremost in the initiation of efforts and regulations to reduce the adverse effects of these solvents in their environment because of the serious problem in the Los Angeles area. The first result was Rule 66 which was quickly adopted in other areas of the State. It has since spread to other states and was finally adopted in a modified form by the Environmental Protection Agency.

Rule 66, however, did not reduce solvent emission in architectural coatings. It only required the substitution of less photochemically reactive solvents.

During the recent past, the California Air Resources Board has taken steps, by developing the ARB Model Rule for Architectural Coatings, to actually reduce emissions of all volatile organic material to about half of the former amount, i.e., to a maximum of 250 grams per liter of applied coating.

Conformance to this ruling presented minimum difficulty for manufacturers of interior wall paints and exterior house paints, which account for approximately 50% of the total architectural coatings used, since most of these coatings are based on latex emulsions and thus contain less than 250 grams per liter of volatile organic material. However, exemptions has to be made for the 14 categories of these coatings, which are listed under the Objective below, and which account for the other 50% of these coatings.

Therefore, CARB wished to determine whether exempt commercial architectural coatings are now available, even from a limited number of suppliers, which can compete in performance with their conventional counterparts and thus enable CARB to remove these categories from the exempt list.

IV OBJECTIVE

The purpose of this study was to obtain and evaluate the performance properties of commercially available high solids or water-based coatings, among the 14 classes now exempt from CARB's model rule for maximum content of organic material, in order to determine if these products are equivalent to the conventional (high solvent) coatings of the same type.

The exempt classes of coatings are as follows:

1. Unpigmented finishes, e.g., varnish, lacquer shellac
2. Semi-transparent stains
3. Opaque stains for use on redwood, cedar mahogany and fir
4. Primers, sealers and undercoaters
5. Wood preservatives (penetrating type)
6. Fire retardant coatings
7. Tile-like, high build glaze coatings
8. Waterproofing coatings except bituminous pavement sealers
9. Industrial maintenance topcoats
10. Metallic coatings
11. Swimming pool paints
12. Sign paints
13. Mastic coatings (15 mils minimum)
14. Multicolor paints

V PROCEDURE

A. The plan followed during this investigation was to obtain CARB conforming paints and coatings and evaluate their properties vs equivalent conventional (solvent-thinned) coatings, preferably from the same suppliers.

However it was realized that the development of CARB conforming products was still in its infancy and that two problems would be encountered in doing so:

1. The technical difficulty (and cost) involved in developing equivalent low VOC coatings, especially with VOC levels below 250 g/l, of paint, less water.

2. The reticence among some manufacturers to participate in the program because they were concerned that CARB would circulate reports containing comparative data on their products.

Therefore, it was planned to cover as wide a territory as possible by:

1. Publicizing the program

2. Writing to a broad spectrum of paint manufacturers in order to make contact with any who might have products to offer.

B. Consequently, the following steps were taken:

1. A publicity release was sent to 23 industry publications and industry associations. See Appendix 1A & 1B.

2. Letters and questionnaires were sent to about 200 major paint manufacturers plus 164 companies in California requesting products which were commercial and could be purchased. See Appendix IIC & IID.

The results were limited, which was not too surprising considering the statements made in A above.

C. In order to encourage a better and broader response, letters and simplified test data forms were sent to about 70 raw material suppliers, to about 50 specialty paint manufacturers (wood preservatives, fire retardant paints, etc.) and to about 35 manufacturers who responded to the Publicity Release. Samples of test paints were requested directly from the supplier in order to encourage submission of products not yet commercial. See Appendix IIE thru IIG. Also, VOC levels of up to about 350 g/l were accepted. Manufacturers were also advised that the sources would be kept confidential.

Thus, over 500 letters and questionnaires or test data forms were issued.

D. As a result of the publicity and survey, a total of 89 low VOC products and 57 equivalent conventional products representing 10 classes were received and tested.

E. Subsequently an additional 20 low VOC and six conventional coatings representing additions to the above, as well as two additional exempt classes, were received and tested.

Consequently a total of 109 low VOC and 63 equivalent conventional coatings, representing 12 exempt classes, were tested.

F. The following tests were conducted, the choice of which depend on the class of coatings being tested:

1. Viscosity
2. Viscosity stability
3. Storage stability
4. Pot life
5. Drying Time
6. Ease of application
7. Gloss
8. Opacity
9. Enamel holdout
10. Resistance to bleeding
11. Sealing of stains
12. Sanding qualities
13. Appearance
14. Adhesion
15. Flexibility
16. Abrasion resistance
17. Water repellency
18. Resistance to cold water

19. Resistance to sodium hypochlorite (bleach)
20. Resistance to Xylol (Xylene)
21. Resistance to mineral spirits
22. Resistance to alcohol - 50% (liquor) and 95% (pure)
23. Resistance to hot water
24. Resistance to butyl acetate (nail polish)
25. Resistance to hydrochloric acid
26. Mud cracking
27. Gloss retention
28. Color retention
29. Metallic leafing
30. Fire retardancy
31. Resistance to salt fog (corrosion)
32. Accelerated weathering

These tests were decided upon to attempt to differentiate between low VOC and equivalent conventional paints.

VII TEST RESULTS

The test data are presented in the Appendix section of this report. See Section IX "Glossary" for a description of the properties tested, Section X "Code and Abbreviation" for an explanation of the terms used and the Test Procedures (Appendix III) for the test methods used.

Inasmuch as some tests are subjective, the observations made have been scored using the following ASTM Scoring Scheme:

Score	Performance	or	Effort
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

The use of this numerical scheme avoids the necessity of inserting verbal descriptions in the Test Data tables.

The test results can be compared and analyzed most effectively by rating the data obtained using a scale of 10 to 0. This has been done using the Rating Scheme described in Appendix IV.

The ratings for all coatings are shown in Table 2 thru 28 which correspond with the data shown in Appendix II.

In order to compare the low VOC vs the equivalent conventional coatings, it is appropriate to compare only those which are considered to be Acceptable in both categories and disregard those which are deficient in one or more important properties.

Comparisons are made only within classes or subclasses, in which there are at least two Acceptable low VOC coatings and one Acceptable conventional coating. The table below summarizes these concepts by listing the following data for each group:

1. Total number of coatings tested.

2. Total number of Acceptable coatings.

3. Average ratings for the Acceptable coatings where at least two low VOC coatings and at least one conventional coating were acceptable.

4. Average VOC for the Acceptable low VOC coatings

Table 29

Average Ratings - Acceptable Coatings

	1A		1B		1C		1D		2		3	
	V	C	V	C	V	C	V	C	V	C	V	C
Total Tested	5	2	4	3	3	2	1	1	2	1	8	5
Acceptable	4	2	4	2	2	1	1	1	2	1	7	4
Viscosity Stability	9.5	9.5	8.5	9.5	7	10	Too Few		9.5	10	9.7	9.5
Storage Stability	10	10	10	10	10	10			9.5	10	8.3	5
Drying Time	9.5	9.5	10	9.7	9	9			9.5	6	10	7.3
Application Ease	10	10	10	10	10	10			10	10	10	10
Opacity	-	-	-	-	-	-			-	-	8.3	9.5
Transparency	-	-	-	-	-	-			4	10	-	-
Adhesion	10	10	10	10	10	10			-	-	-	-
Flexibility	10	10	9.5	10	10	10			-	-	-	-
Water Repellancy	-	-	-	-	-	-			7	9	7.9	9.5
Resistance To -												
- Abrasion	9.7	10	8.3	7.3	9.5	10			-	-	-	-
- Alcohol	9.5	10	9.5	10	-	-			-	-	-	-
- Mineral Spirits	10	10	10	10	-	-			-	-	-	-
- Hot Water	10	10	10	10	-	-			-	-	-	-
- Cold Water	10	10	9.5	9.7	-	-			-	-	-	-
Weathering	-	-	-	-	9.5	10			10	10	10	9
Average VOC (g/l)*	329		292		275				121		119	

V -- Low VOC

C - Conventional

- - Not applicable

* Based on acceptable samples for which data was received.

Table 29 (Cont)

Average Ratings - Acceptable Coatings

	4A-1		4A-2		4A-Z		4B		4C		4D	
	V	C	V	C	V	C	V	C	V	C	V	C
Total Tested --------	13	9	3	2	3	2	5	4	5	2	1	1
Acceptable --------	2	6	0	1	2	1	3	1	5	2	1	1
Viscosity Stability	9.5	8.3	Too Few		10	10	9	9	9.2	10	Too Few	
Storage Stability	9.5	6.7			10	9	7.3	8	8.4	6.5		
Pot Life	-	-			10	10	-	-	-	-		
Drying Time	6	8.5			9	8	10	4	10	10		
Application Ease	10	10			10	10	10	10	10	10		
Opacity	8	10			10	10	7.3	6	6	6		
Adhesion	10	10			10	10	10	9	10	10		
Bleeding Resistance	-	-			-	-	6.7	8	-	-		
Sanding Qualities	-	-			-	-	-	-	-	-		
Enamel Holdout	8.5	9.2			-	-	9.3	10	9.2	8.5		
Stain Sealing -	-	-			-	-	-	-				
Rusty water									9.8	10		
Coffee									5.6	10		
Tea									5.2	10		
Grease									8.6	6		
Flexibility	-	-			-	-	-	-	-	-		
Corrosion Resist.	8	5.7			10	10	-	-	-	-		
Weathering	8.5	8			10	8	9.3	8	-	-		
Average VOC (g/l)	44				61		126		100			

Table 29 (Cont)

Average Ratings - Acceptable Coatings

	6		7		8A		8B		9A		9B	
	V	C	V	C	V	C	V	C	V	C	V	C
Total Tested	5	1	6	4	3	2	6	1	7	7	6	4
Acceptable	0	0	2	2	0	0	0	1	3	4	2	0
Viscosity Stability	None		6	8.5	None		Too Few		9.3	9	Too Few	
Storage Stability			9.5	9					8.7	8.3	Conv.	
Pot Life			6	9					-	-		
Drying Time			7	9					10	6.7		
Application Ease			8.5	9.5					9.7	10		
Opacity			-	-					8	9.5		
Adhesion			10	10					10	10		
Gloss Retention			10	9					-	-		
Color Retention			6	4					-	-		
Flexibility			10	10					10	10		
Resistance To -									-	-		
- Abrasion			9.5	9								
- Water			10	10								
- M.S.			-	-								
- Corrosion			-	-								
Weathering			-	-					10	8		
Average VOC (g/l)			220						258			

Clr - Clears

Table 29 (Cont)

Average Ratings - Acceptable Coatings

	9C		10		11		13A		13B		14	
	V	C	V	C	V	C	V	C	V	C	V	C
Total Tested	4	2	2	3	6	1	6	2	4	1	1	1
Acceptable	1	0	2	1	1	1	0	0	4	1	0	0
Viscosity Stability	Too Few		10	9	Too Few		None		9.7	10	None	
Storage Stability			8	10					8.3	6		
Drying Time			10	8					8.5	6		
Application Ease			10	10					8.5	4		
Opacity			10	10					10	10		
Adhesion			10	10					9	10		
Flexibility			10	10					-	-		
Mud Cracking			-	-					10	10		
Metallic Leafing			10*	10					-	-		
Weathering			4	9					-	-		
Average VOC(g/l)			ND						26			

* Where applicable

ND - No data