Quarterly Progress Report on

Standard Agreement No. 09-428

For the Period

July 1, 2011 through September 30, 2011

Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating

Prepared for California Air Resources Board

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September 30, 2011

Disclaimer-

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Acknowledgements

This report was submitted in partial fulfillment of ARB Standard Agreement Number 09-428, Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating, by the Cal Poly Corporation under sponsorship of the California Air Resources Board.

A. Summary

Local air districts' architectural coating rules that are based on the California Air Resources Board's (ARB) 2007 architectural coatings Suggested Control Measure are scheduled to reduce the volatile organic compound (VOC) limit of specialty primers, sealers, and undercoaters (SPSU) from 350 g/L to 100 g/L in January of 2012. Currently the stain blocking primers that are considered most effective are solvent based primers that have VOC contents much higher than 100 g/L. The goal of this study is to determine if primers on the market today with a VOC content of 100 g/L or less can provide acceptable performance in comparison to primers with VOC contents greater than 100 g/L. Fifteen commercially available primers, both water based and solvent based, were selected for this project. Physical properties of all fifteen primers and test results on their ability to block household stains on laboratory draw-down chart paper and dry wall as well as tannin from cedar and redwood were described in previous quarterly reports. This report describes the results of a final set of experiments conducted to determine the performance of the fifteen primers in blocking fire and water damaged wood substrates.

B. Introduction

Current regulations in California allow SPSU paints, also referred to as stain blocking primers, to have a VOC content of up to 350 g/L. By January 2012, several air districts' rules will lower the VOC limit to 100 g/L. The best performing stain blocking primers currently on the market, as accepted within the industry, are several oil based primers with a VOC limit of 350 g/L. However, a number of products with less than 100 g/L VOC have been introduced to this market by paint and coating companies in recent years. A panel made up of companies and organizations having a vested interest in the project (see September-December 2010 quarterly report of this project for a listing) recommended fifteen stain-blocking primer coatings for testing, along with five other coatings to be used as standard primers and topcoats, when needed, during the course of testing. Characterization results of the fifteen chosen stain-blocking primers, along with the five topcoats and primers chosen as standard paints can be found in a previous quarterly report (1). Results of stain blocking tests conducted with household markers on laboratory draw-down charts and drywall (ASTM D7514-09) and tannin blocking tests conducted with cedar and redwood substrates, presented in other quarterly reports (2,3), indicated that as a class, water-based stain-blocking primers performed similarly to solvent-based primers in blocking stains from household markers. Tannin blocking tests on cedar boards indicated there are water based coatings in the market that can match the performance of best solvent based coatings. However, solvent based coatings outperformed water based coatings in blocking redwood stains. Additional tests indicated that several water based primers, when applied as two coats, can match the best performing solvent based primers in blocking redwood stains. Attempts were made during the reporting period covered in this report to acquire fire, smoke, and water damaged substrates for a final series of tests. These attempts yielded only limited success. Therefore it was decided that such

substrates would be prepared under laboratory conditions and used for evaluating the performance of the fifteen stain blocking primers. Results of these evaluations are presented.

C. Materials and Methods

The fifteen stain blocking primers selected for testing are,

- Zinsser Shellac-Based B-I-N (shellac based)
- Zinsser High-Hide Cover Stain (oil based)
- Zinsser Odorless (oil based)
- Zinsser Smart Prime (water based)
- Zinsser Bulls Eye Zero (water based)
- Zinsser Waterborne Cover Stain
- KILZ Complete (oil based)
- KILZ Premium (water based)
- Behr Premium Plus Interior/Exterior Primer and Sealer (oil based)
- Behr Premium Plus Interior Primer and Sealer (water based)
- Benjamin Moore Fresh Start Alkyd Primer
- Benjamin Moore Fresh Start All-Purpose 100% Acrylic Primer
- Kelly Moore Weather Shield Exterior Alkyd Primer for Stain Blocking (oil based)
- Sherwin Williams Multi-Purpose Latex Primer, and
- Akzo Nobel P&P Gripper Stain Killer (water based)

The standard primers and topcoats used are Vinylastic Premium Wall Sealer, ENSO Interior Primer Low Odor Zero VOC, ENSO Interior Eggshell interior topcoat, UltraGrip Premium Interior/Exterior Multi-Purpose Primer, and Evershield Exterior Eggshell exterior topcoat, supplied by the Dunn-Edwards Company. Physical property testing results of these paints and the fifteen stain-blocking primers were presented in a previous quarterly report (1). In order to conceal the identity of stain-blocking primers the seven solvent based coatings were assigned the codes SB1, SB2, SB3, SB4, SB5, SB6, and SB7, whereas the eight water based coatings were assigned the codes WB1, WB2, WB3, WB4, WB5, WB6, WB7, and WB8.

The substrates employed for the tests conducted during this reporting period were redwood and Douglas fir boards purchased from a local Home Depot store. In addition, two water damaged pieces of wood, a fire damaged piece of wood, and several undamaged ceiling tiles were also included in the study.

The redwood and Douglas fir panels were purchased from the local Home Depot store. These panels were burned under controlled conditions in an attempt to simulate burning in a real fire. The level of burning was such that the panels would be painted over rather than discarded in a restoration effort. Controlled burning involved subjecting the redwood and Douglas fir panels to a Coleman propane torch. The torch was applied directly to the surface of the wood (about 3 inches from the surface) for about 90 seconds, which resulted in an even burn of the panel surface. Figure 1 shows a Douglas fir panel before and after being burned. Figure 2 illustrates the typical degree of burning achieved for all panels used for testing.

Figure 1: Photograph of a wood panel before (left) and after (right) being subjected to the flame from Coleman burner

Figure 2: Photograph of a batch of wood panels after being subjected to the flame from Coleman burner

The burned panels were left undisturbed for 24 hours. Each panel then had the test primer applied on three sections. After 24 hours of drying time of the primer, the Dunn Edwards ENSO Interior Eggshell top coat was applied over the primer and allowed to dry for an additional 24 hours. Stain blocking primer performance was ranked the same way as described in earlier quarterly reports, visually within a scale from 1-10, with 1 being the worst and 10 being the best.

A fire damaged piece of wood (2"x4" cross-section, 36" long) from the ceiling of a local restaurant in San Luis Obispo was obtained. The piece of wood had been burned in a fire that occurred in March 2010. The wood surface contained charred material but was still intact when obtained for the study (Figure 3). The wood surface was wiped clean before application of coatings. Narrow stripes of each stain blocking primer and topcoat were applied across the length of the panel according to the procedure described above for panels burned under controlled conditions.

Figure 3: Photograph of wood sample obtained from a restaurant fire in San Luis Obispo, CA.

The water damaged wood samples were obtained from a residence in San Luis Obispo. Two wood panels (9"x18" each), that were put together in a checkerboard pattern (see Figure 4) were left in the garage in an area where there was a leak in the ceiling. The panels had been subjected to water damage for approximately two months. They were dry but slightly moldy when obtained for the study. The extent of water damage related staining was similar on the two panels. Both of the panels were initially wiped with de-ionized water and dried with clean tissue paper. One of the panels was used for testing the solvent based primers, whereas the other panel was used for testing the waterborne primers. One of the wood panels coated with a solvent based stain blocking primer is shown in Figure 4. The other solvent based primers were applied on the remaining area. The panel was left to dry for 24 hours at ambient temperature, and then the Dunn Edwards ENSO Interior Eggshell topcoat was applied on each primer. The top coat was also allowed to dry for 24 hours. The same procedure was repeated for

waterborne primers using the remaining wood panel. Performance of each stain blocking primer was ranked visually in the same scale (1-10) as before.

Figure 4. Photograph of a water damaged wood panel recovered from a residence in San Luis Obispo, CA. One of the test primers has been applied on the panel.

Several brand new acoustical ceiling tile panels were supplied by a member of the industrial advisory panel for inclusion in the study. Attempts were made to create stains on the face of the tiles by wetting the back side with water that was allowed to diffuse to the face of the panel. This approach produced water marks on the face, but the stains were not severe at all. It was determined that the stain severity on the ceiling tiles were not high enough to differentiate the performance of the fifteen test primers. No coating tests were conducted on the ceiling tiles.

D. Results and Discussion

Stain blocking rankings of all fifteen primers on redwood and Douglas fir that were burned under controlled laboratory conditions are shown in Table 1 and Figures 5 & 6. The rankings represent the averages of three data points per primer applied on three positions on each panel as described in the Materials and Methods Section of this report. The two classes of primers, solvent based and water based, show similar performance with at least one primer from each category exhibiting excellent performance. Results for water based primers were quite different when they were tested on unburned redwood (3). In those tests, single coats of the water based primers performed worse than the solvent based category. Results for Douglas fir indicate that solvent based primers perform better on Douglas fir than on redwood. As a class, water based coatings perform similarly on both types of wood. Water based primers WB2 and WB4 show excellent performance.

Table 1. Stain blocking rankings of primers applied on redwood and Doulas fir panels Burned under laboratory conditions

Primer Identification	Ranking on Redwood	Ranking on Douglas Fir
SB1	7.3	9.7
SB2	8.3	9.7
SB3	9.7	9.3
SB4	6.3	8.7
SB5	8.3	9.7
SB6	5.7	8.7
SB7	9.0	9.3
WB1	6.0	8.0
WB2	10.0	10.0
WB3	7.3	7.3
WB4	8.7	10.0
WB5	4.0	4.3
WB6	8.7	9.3
WB7	8.7	8.3
WB8	6.3	7.7

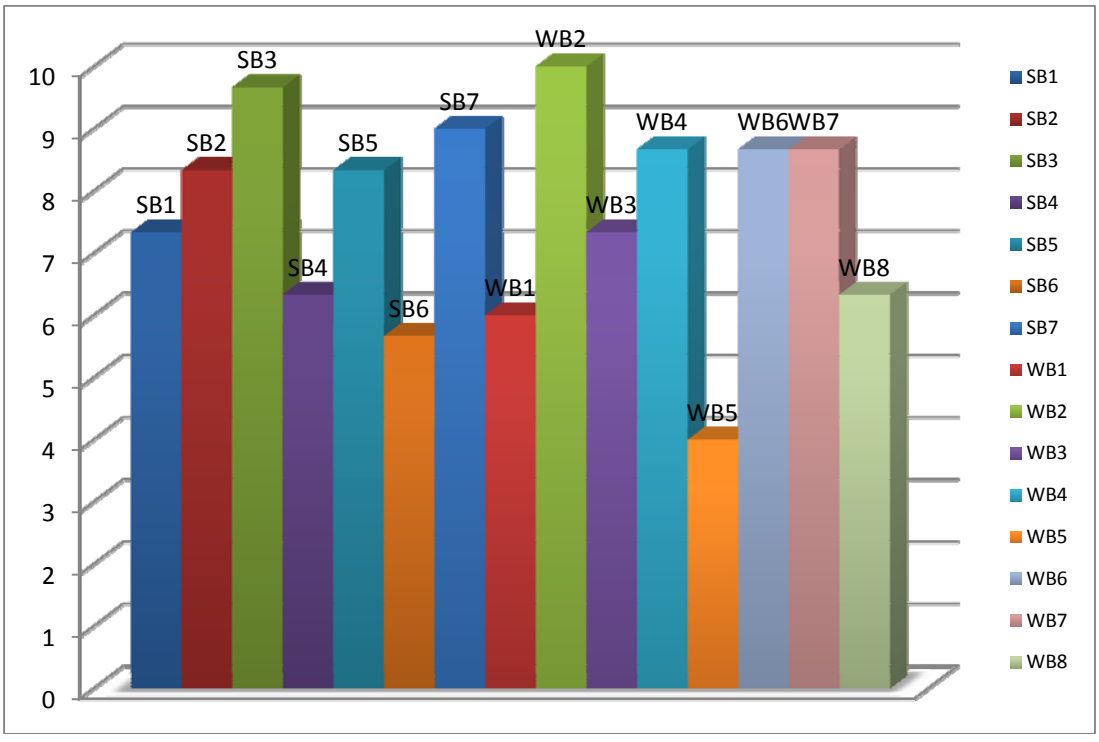

Figure 5. Stain blocking rankings of primers applied on redwood burned under laboratory conditions.

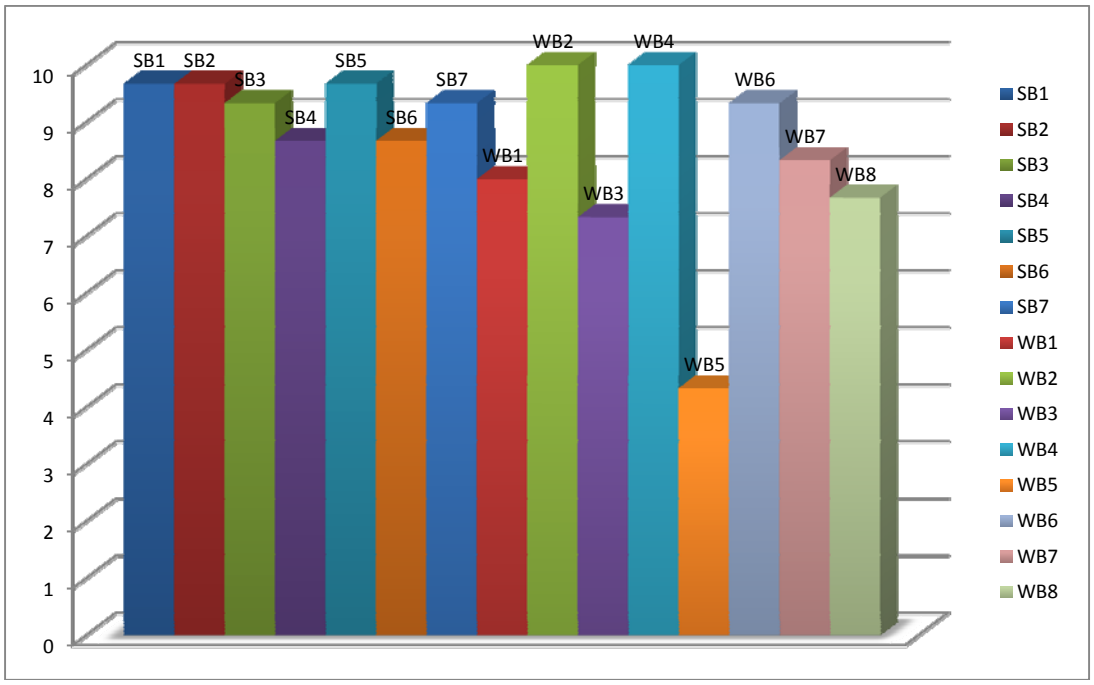

Figure 6. Stain blocking rankings of primers on Douglas fir burned under laboratory conditions.

Stain blocking rankings for the fifteen primers on the wood samples that were recovered from real fire and water-damage are shown in Table 2 and Figures 7 & 8. These rankings are not averages of three data points as in Table 1 and Figures 5 & 6 as there wasn't enough area on the panels to coat each primer more than once. They represent single data point per each primer. Results on the fire damaged wood panel indicate similar performance by both solvent based and water based categories of primers. On the water damaged sample, solvent based primers outperform the water based primers; however, WB3 and WB6 primers' performance is similar to many solvent based primers, and WB8 matches the performance of the best solvent based primer.

Table 2. Stain blocking rankings on wood panels recovered from real fire and water damage sites

Primer Identification	Ranking on Fire Damaged Panel	Ranking on Water Damaged Panel
SB1	8	9
SB2	10	10
SB3	9	10
SB4	10	9
SB5	10	9
SB6	9	10
SB7	9	9
WB1	8	7
WB2	8	7
WB3	10	9
WB4	9	7
WB5	8	6
WB6	9	9
WB7	8	6
WB8	9	10

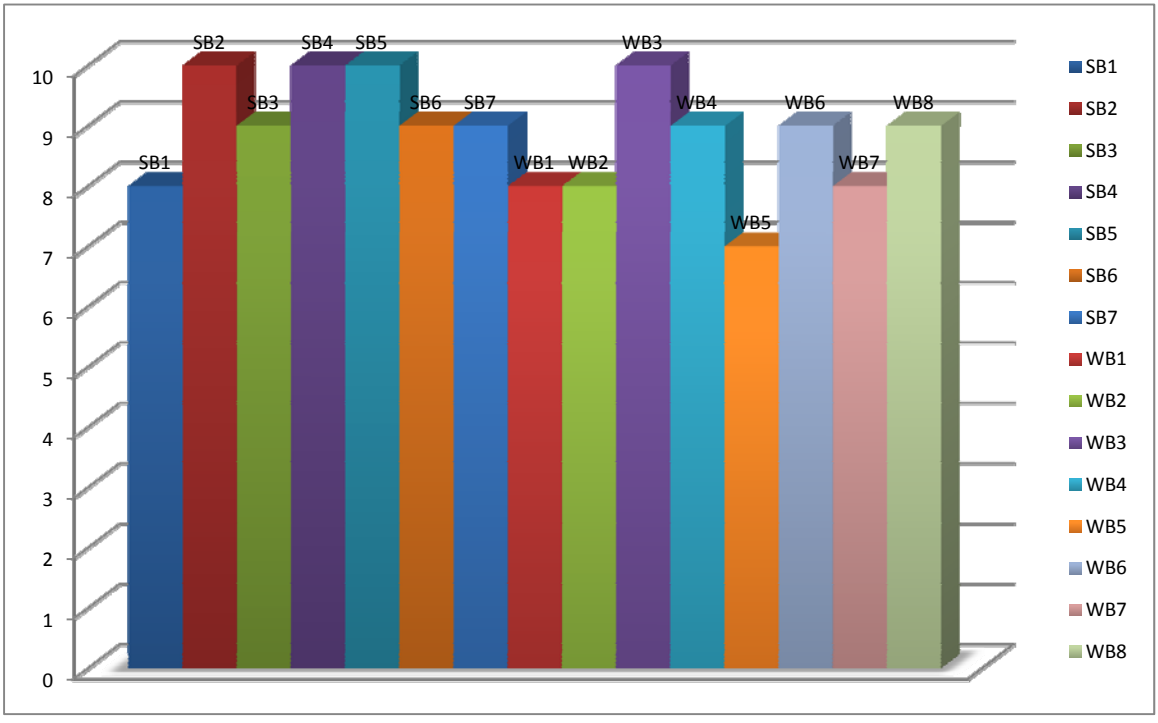

Figure 7. Stain blocking rankings of primers on real fire-damaged wood panel

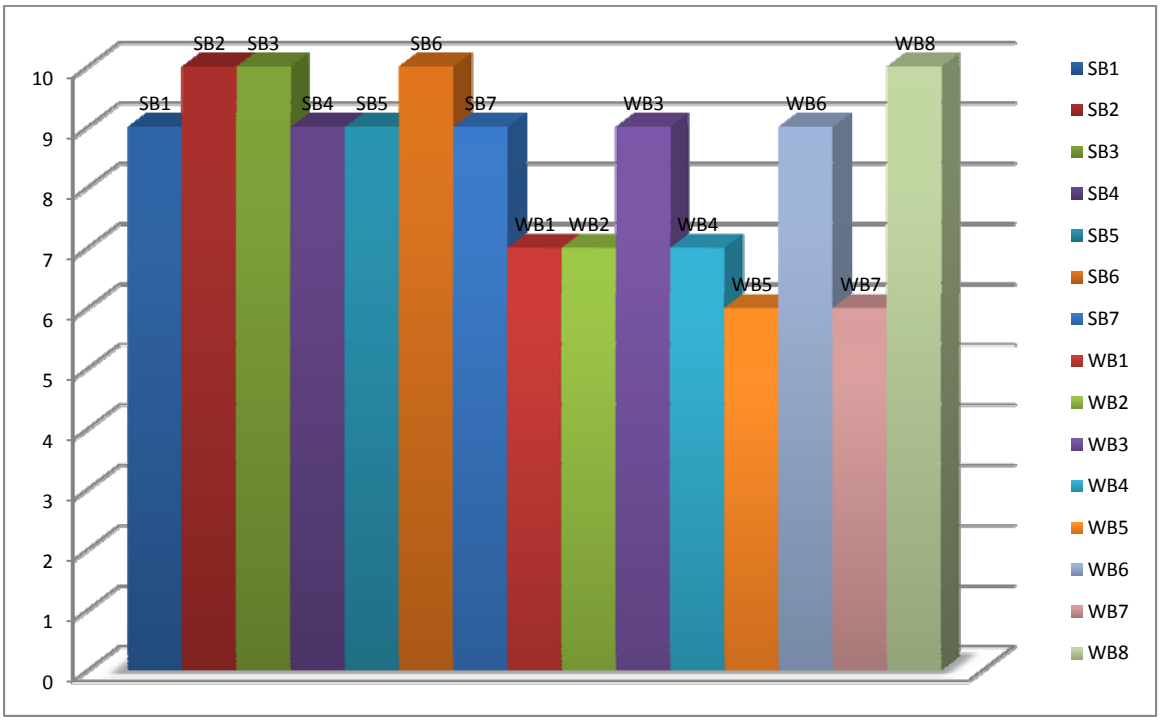

Figure 8. Stain blocking rankings of primers on real water-damaged wood panel

E. Conclusions

The ability of the fifteen primers in blocking stains caused by fire and water damage on wood panels was studied. Results indicate there are water based primers (i.e., coatings containing less than 100 g/L VOC) that can match the best solvent based primers (i.e., coatings containing less than 350 g/L VOC) on these substrates. Experimental work on this project is complete as of the end of the reporting period. The next step is to prepare the final project report.

F. References

1. "Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating", R. H. Fernando and D. R. Jones, Second Quarterly Report of Project Sponsored by California Air Resources Board (Standard Agreement No. 09-428), December 31, 2010
2. "Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating", R. H. Fernando and D. R. Jones, Third Quarterly Report of Project Sponsored by California Air Resources Board (Standard Agreement No. 09-428), March 31, 2011
3. "Low Volatile Organic Compound (VOC) Stain Blocking Specialty Primer Coating", R. H. Fernando and D. R. Jones, Fourth Quarterly Report of Project Sponsored by California Air Resources Board (Standard Agreement No. 09-428), June 30, 2011