

Phase II Report

November 23, 2005

Executive Summary

Products Listing by Category

	Published VOC	Grouping	
Group 4:	Primers/Sealers/Undercoaters		
Product A2	142 g/L	>100 g/L	H
Product B2	125 g/L	>100 g/L	H
Product C2	63 g/L	≤100 g/L	L
Product D2	58 g/L	≤100 g/L	L
Group 5:	Waterproofing & Concrete/Masonry Sealers		
Product E2	390 g/L	> 100 g/L	H
Product F2	350 g/L	> 100 g/L	H
Product G2	92 g/L	≤100 g/L	L
Product H2	86 g/L	≤100 g/L	L
Product I2	< 65 g/L	≤100 g/L	L
Product J2	12 g/L	≤100 g/L	L
Product K2	270 g/L	> 100 g/L	H
Group 6:	Exterior Stains		
Product L2	250 g/L	>100 g/L	H
Product M2	0 g/L	≤100 g/L	L
Product N2	0 g/L	≤100 g/L	L
Product O2	0 g/L	≤100 g/L	L
Group 7:	Clear Wood Finishes		
Product P2	439 g/L	>275 g/L	H
Product Q2	347 g/L	>275 g/L	H
Product R2	250 g/L	≤275 g/L	L
Product S2	57 g/L	≤275 g/L	L
Product T2	50 g/L	≤275 g/L	L
Product U2	168 g/L	≤275 g/L	L

Number of Products Tested by Published VOC Range

Category	Products >100 g/L	Products ≤100 g/L
Primers/Sealers/Undercoaters	2	2
Concrete/Masonry	3	4
Exterior Stains	1	3

Category	Products >275 g/L	Products ≤275 g/L
Clear Wood Finishes	2	4

Tests for General Properties Summary

Percent Nonvolatile Summary*

	Published VOC	Grouping		Percent Nonvolatile
				Experimental
Group 4:	Primers, Sealers, and Undercoaters			
Product A2	142 g/L	>100 g/L	H	56.30
Product B2	125 g/L	>100 g/L	H	50.22
Product C2	63 g/L	≤100 g/L	L	54.48
Product D2	58 g/L	≤100 g/L	L	56.93
Group 5:	Concrete/Masonry Sealers			
Product E2	390 g/L	> 100 g/L	H	75.22
Product F2	350 g/L	> 100 g/L	H	25.54
Product G2	92 g/L	≤100 g/L	L	53.80
Product H2	86 g/L	≤100 g/L	L	19.03
Product I2	< 65 g/L	≤100 g/L	L	12.42
Product J2	12 g/L	≤100 g/L	L	3.55
Product K2	270 g/L	> 100 g/L	H	3.05
Group 6:	Exterior Stains			
Product L2	250 g/L	>100 g/L	H	62.78
Product M2	0 g/L	≤100 g/L	L	29.98
Product N2	0 g/L	≤100 g/L	L	23.24
Product O2	0 g/L	≤100 g/L	L	34.49
Group 7:	Clear Wood Finishes			
Product P2	439 g/L	>275 g/L	H	38.36
Product Q2	347 g/L	>275 g/L	H	64.88
Product R2	250 g/L	≤275 g/L	L	32.34
Product S2	57 g/L	≤275 g/L	L	31.74
Product T2	50 g/L	≤275 g/L	L	29.54
Product U2	168 g/L	≤275 g/L	L	32.61

*Average Values

Stability Summary

	Grouping	Stormer KU (original)	Stormer KU (post-test)	Overall Character**
Group 4:	Primers, Sealers, Undercoaters			
Product A2	H	106	110	8
Product B2	H	117	128	4
Product C2	L	113	123	6
Product D2	L	104	108	6
Group 5:	Concrete/Masonry Sealers			
Product E2	H	127	140	8
Product F2	H	< 53*	< 53*	8
Product G2	L	100	99	6
Product H2	L	< 53*	< 53*	10
Product I2	L	<53*	< 53*	8
Product J2	L	<53*	< 53*	8
Product K2	H	<53*	< 53*	6
Group 6:	Exterior Stains			
Product L2	H	<53*	< 53*	8
Product M2	L	58	62	8
Product N2	L	53	53	6
Product O2	L	55	55	6
Group 7:	Clear Wood Finishes			
Product P2	H	< 53*	< 53*	8
Product Q2	H	61	60	10
Product R2	L	55	57	10
Product S2	L	55	55	8
Product T2	L	< 53*	< 53*	10
Product U2	L	58	58	10

* A viscosity of “< 53” indicates that the given coating’s viscosity is below the measurable range

**Overall Character – Ratings: 0-10; a rating of 0 denotes failure

Stability Summary - Gloss Measurements

	Grouping	20°Mean	20 SD	60°Mean	60 SD	85°Mean	85 SD
Group 4:	Primers, Sealers, Undercoaters						
Product A2	H	1.9	0.1	9.1	0.2	11.0	0.2
Product B2	H	3.2	0.1	18.6	0.4	34.3	0.2
Product C2	L	1.3	0.1	3.6	0.1	4.6	0.1
Product D2	L	2.2	0.1	10.4	0.2	10.2	0.2
Group 5:	Concrete/Masonry Sealers						
Product E2	H	N/A – Textured					
Product F2	H	<i>2.6</i>	<i>0.2</i>	<i>20.2</i>	<i>0.8</i>	<i>54.5</i>	<i>1.6</i>
Product G2	L	1.4	0.1	2.7	0.1	1.3	0.1
Product H2	L	<i>1.4</i>	<i>0.1</i>	<i>6.4</i>	<i>0.6</i>	<i>29.8</i>	<i>1.4</i>
Product I2	L	<i>1.6</i>	<i>0.2</i>	<i>8.6</i>	<i>1.0</i>	<i>42.4</i>	<i>3.4</i>
Product J2	L	<i>2.7</i>	<i>0.2</i>	<i>19.3</i>	<i>1.4</i>	<i>52.3</i>	<i>2.0</i>
Product K2	H	<i>1.5</i>	<i>0.1</i>	<i>7.3</i>	<i>1.0</i>	<i>37.8</i>	<i>1.8</i>
Group 6:	Exterior Stains						
Product L2	H	0.9	0.6	4.4	0.2	1.7	0.2
Product M2	L	66.0	0.4	85.4	0.2	94.9	0.6
Product N2	L	8.8	<i>1.0</i>	<i>40.7</i>	<i>2.4</i>	<i>50.2</i>	<i>2.8</i>
Product O2	L	<i>28.6</i>	<i>0.6</i>	<i>71.5</i>	<i>1.0</i>	<i>71.8</i>	<i>2.2</i>
Group 7:	Clear Wood Finishes						
Product P2	H	9.5	0.6	45.5	0.8	71.4	1.8
Product Q2	H	84.9	0.4	90.3	1.0	95.3	1.0
Product R2	L	5.2	1.2	24.4	2.0	36.0	1.0
Product S2	L	10.8	0.8	43.7	1.0	71.3	0.6
Product T2	L	64.7	1.4	84.7	0.6	89.4	0.6
Product U2	L	17.3	1.0	51.5	0.6	74.2	1.4

*Gloss values in italics were measured over the unsealed portion of the Leneta chart because a consistent film over the sealed portion was unattainable due to penetrating characteristics

Stormer and Cone and Plate Viscosities Summary*

	Grouping	Stormer (KU)		Cone and Plate (P)	
		Average	Temp. (°C)	Average	Temp (°C)
Group 4:	Primers, Sealers, Undercoaters				
Product A2	H	106	25	1.021	25
Product B2	H	117	25	2.363	25
Product C2	L	113	25	2.592	25
Product D2	L	104	25	0.925	25
Group 5:	Concrete/Masonry Sealers				
Product E2	H	127	25	N/A – Textured***	
Product F2	H	< 53	25	Not Applicable**	
Product G2	L	100	25	0.676	25
Product H2	L	< 53	25	Not Applicable**	
Product I2	L	< 53	25	Not Applicable**	
Product J2	L	< 53	25	Not Applicable**	
Product K2	H	< 53	25	Not Applicable**	
Group 6:	Exterior Stains				
Product L2	H	< 53	25	Not Applicable**	
Product M2	L	58	25	Not Applicable**	
Product N2	L	53	25	Not Applicable**	
Product O2	L	55	25	Not Applicable**	
Group 7:	Clear Wood Finishes				
Product P2	H	< 53	25	0.448	25
Product Q2	H	61	25	2.967	25
Product R2	L	56	25	0.327	25
Product S2	L	55	25	0.342	25
Product T2	L	< 53	25	Not Applicable**	
Product U2	L	58	25	0.426	25

*Spindle = 3 (Group 4), 2 (Product Q2), 1 (Group 5 and Group 7),

*Shear Rate = 12000s⁻¹

*Average Values

**These coatings had viscosities below the measurable range of the instrument

***Textured coatings cannot be tested with the cone and plate viscometer

Freeze-Thaw Resistance: Pass/Fail Summary*

	Grouping	After 1 Cycle	After 3 Cycles	After 5 Cycles	After 8 Cycles
Group 4:	Primers, Sealers, and Undercoaters				
Product A2	H	Pass	Pass	Pass	Pass
Product B2	H	Fail	Fail	Fail	Fail
Product C2	L	Pass	Pass	Pass	Pass
Product D2	L	Fail	Fail	Fail	Fail
Group 5:	Concrete/Masonry Sealers				
Product E2	H	N/A – Solvent Based			
Product F2	H	Pass	Pass	Pass	Pass
Product G2	L	Pass	Pass	Pass	Pass
Product H2	L	Pass	Pass	Pass	Pass
Product I2	L	Pass	Pass	Pass	Pass
Product J2	L	Pass	Pass	Pass	Pass
Product K2	H	Pass	Pass	Pass	Pass
Group 6:	Exterior Stains				
Product L2	H	N/A – Solvent Based			
Product M2	L	Pass	Pass	Pass	Pass
Product N2	L	Pass	Pass	Pass	Pass
Product O2	L	Fail	Fail	Fail	Fail
Group 7:	Clear Wood Finishes				
Product P2	H	N/A – Solvent Based			
Product Q2	H	N/A – Solvent Based			
Product R2	L	Pass	Pass	Pass	Pass
Product S2	L	Pass	Pass	Pass	Pass
Product T2	L	Fail	Fail	Fail	Fail
Product U2	L	Pass	Fail	Fail	Fail

*Average Values

Mechanical Dry Time Summary*

	Grouping	Set-Touch	Tack-Free	Dry-Hard	Dry-Through
Group 4:	Primers, Sealers, and Undercoaters				
Product A2	H	3.0	13.5	24.0	104.3
Product B2	H	5.3	18.0	27.8	87.0
Product C2	L	2.3	16.5	21.8	231.0
Product D2	L	1.5	10.5	69.0	85.5
Group 5:	Concrete/Masonry Sealers				
Product E2	H	N/A			
Product F2	H	N/A			
Product G2	L	15.0	75.0	144.8	156.0
Product H2	L	N/A			
Product I2	L	N/A			
Product J2	L	N/A			
Product K2	H	N/A			
Group 6:	Exterior Stains				
Product L2	H	N/A			
Product M2	L	N/A			
Product N2	L	N/A			
Product O2	L	N/A			
Group 7:	Clear Wood Finishes				
Product P2	H	24.0	30.8	45.0	282.0
Product Q2	H	94.5	130.5	249.0	> 6 Hours
Product R2	L	16.5	26.3	37.5	72.8
Product S2	L	8.3	30.8	63.8	131.3
Product T2	L	14.3	23.3	33.0	> 6 Hours
Product U2	L	11.3	15.0	27.0	34.5

*Average values; times in minutes; stylus diameter = 1mm; speed = 6 hours

Ambient Dry Time Summary*

	Grouping	Set-Touch	Dust-Free	Tack-Free	Dry-Hard	Dry-Through
Group 4:	Primers, Sealers, and Undercoaters					
Product A2	H	28	34	74	78	131
Product B2	H	17	21	62	65	69
Product C2	L	32	36	38	49	57
Product D2	L	23	28	35	43	51
Group 5:	Concrete/Masonry Sealers					
Product E2	H	N/A				
Product F2	H	N/A				
Product G2	L	N/A				
Product H2	L	N/A				
Product I2	L	N/A				
Product J2	L	N/A				
Product K2	H	N/A				
Group 6:	Exterior Stains					
Product L2	H	N/A				
Product M2	L	N/A				
Product N2	L	N/A				
Product O2	L	N/A				
Group 7:	Clear Wood Finishes					
Product P2	H	N/A				
Product Q2	H	N/A				
Product R2	L	N/A				
Product S2	L	N/A				
Product T2	L	N/A				
Product U2	L	N/A				

*Times are in minutes, and are the average of two samples

Gloss Summary*

	Grouping	20°Mean	20° SD	60°Mean	60° SD	85°Mean	85° SD
Group 4:	Primers, Sealers, and Undercoaters						
Product A2	H	1.9	0.1	7.8	0.2	8.2	0.2
Product B2	H	2.7	0.2	14.6	0.2	22.6	0.4
Product C2	L	1.3	0.1	3.3	0.2	4.4	0.2
Product D2	L	2.0	0.1	9.0	0.2	8.0	0.2
Group 5:	Concrete/Masonry Sealers						
Product E2	H	N/A - Textured					
Product F2	H	N/A – Penetrating					
Product G2	L	1.4	0.1	2.8	0.2	1.4	0.1
Product H2	L	N/A – Penetrating					
Product I2	L	N/A – Penetrating					
Product J2	L	N/A – Penetrating					
Product K2	H	N/A – Penetrating					
Group 6:	Exterior Stains						
Product L2	H	N/A – Penetrating					
Product M2	L	N/A – Penetrating					
Product N2	L	N/A – Penetrating					
Product O2	L	N/A – Penetrating					
Group 7:	Clear Wood Finishes						
Product P2	H	16.0	1.0	56.6	0.9	83.2	2.6
Product Q2	H	85.5	0.8	90.7	0.4	96.4	2.3
Product R2	L	7.5	1.5	31.4	3.0	47.0	3.0
Product S2	L	13.3	1.7	47.9	2.4	72.0	2.1
Product T2	L	52.8	5.0	80.5	1.0	92.5	1.2
Product U2	L	16.3	1.4	51.5	1.6	77.9	1.3

*Average values

Hide Summary – Contrast Ratio*

	Grouping	3 mil #1	3 mil #2	2 mil #1	2 mil #2
Group 4:	Primers, Sealers, and Undercoaters				
Product A2	H	0.96	0.96	0.96	0.95
Product B2	H	0.96	0.95	0.95	0.95
Product C2	L	0.92	0.92	0.92	0.91
Product D2	L	0.97	0.97	0.96	0.97
Group 5:	Concrete/Masonry Sealers				
Product E2	H	N/A – Texturing Prevents Bar Draw Downs			
Product F2	H	N/A – Penetrating			
Product G2	L	0.94	0.96	0.92	0.93
Product H2	L	N/A – Penetrating			
Product I2	L	N/A – Penetrating			
Product J2	L	N/A – Penetrating			
Product K2	H	N/A – Penetrating			
Group 6:	Exterior Stains				
Product L2	H	N/A – Penetrating			
Product M2	L	N/A – Penetrating			
Product N2	L	N/A – Penetrating			
Product O2	L	N/A – Penetrating			
Group 7:	Clear Wood Finishes				
Product P2	H	N/A - Clear			
Product Q2	H	N/A - Clear			
Product R2	L	N/A - Clear			
Product S2	L	N/A - Clear			
Product T2	L	N/A - Clear			
Product U2	L	N/A - Clear			

*Average values

Tests for Primers, Sealers and Undercoaters Summary

Adhesion Direct to Wood – Battelle Torque Summary*

	Grouping	Adhesion (lb/in²)	Failure Mechanism
Group 4:	Primers, Sealers, and Undercoaters		
Product A2	H	23.7	Primer - Cohesive
Product B2	H	16.8	Primer - Cohesive
Product C2	L	20.8	Primer – Cohesive**
Product D2	L	19.5	Primer - Cohesive

*Average Values

**One sample had adhesion to substrate failure

Adhesion Direct to Wood – Cross-hatch Adhesion (ASTM D3359) Summary*

	Grouping	Rating	Failure Mechanism**
Group 4:	Primers, Sealers, and Undercoaters		
Product A2	H	3.7	Substrate Failure/Primer Adhesion
Product B2	H	3.7	Substrate Failure/Primer Adhesion
Product C2	L	4	Substrate Failure/Primer Adhesion
Product D2	L	4	Substrate Failure/Primer Adhesion

*Average Values

**All samples had both adhesion to substrate failure and substrate cohesive failure

Overcoat Adhesion – Battelle torque Summary

	Grouping	Adhesion (lb/in²)	Failure Mechanism
Group 4:	Primers, Sealers, and Undercoaters		
Product A2	H	50.2	Substrate Failure**
Product B2	H	58.8	Substrate Failure
Product C2	L	50.0	Substrate Failure/Topcoat Adhesion***
Product D2	L	46.6	Topcoat Adhesion

*Average Values

**One sample had topcoat adhesion failure

***All three samples had substrate cohesive failure and topcoat adhesion failure

Overcoat Adhesion – Cross-hatch Adhesion (ASTM D3359) Summary*

	Grouping	Rating	Failure Mechanism
Group 4:	Primers, Sealers, and Undercoaters		
Product A2	H	4	Topcoat Adhesion
Product B2	H	4	Topcoat Adhesion/Primer Adhesion**
Product C2	L	3.3	Primer Adhesion***
Product D2	L	3.3	Topcoat Adhesion****

*Average Values

**These samples exhibited both topcoat adhesion failure and primer adhesion failure

***One sample also had substrate cohesive failure

****Two samples also had substrate failure

Stain Bleed Through Resistance, Color Change (ΔE) Summary*

	Lipstick	Red Crayon	Grape Juice	Mustard	Instant Coffee	Hot Pink Highlighter	Carbon Black
Group 4:	Primers, Sealers, and Undercoaters						
Product A2	3.70	2.23	1.40	2.49	9.31	9.07	1.64
Product B2	5.97	1.88	1.12	0.76	8.05	8.07	0.86
Product C2	1.51	0.59	2.23	0.60	14.29	6.42	1.14
Product D2	1.93	0.76	2.20	0.74	11.83	9.47	0.59

*Average values

Tannin Stain Resistance, Color Change (ΔE) Summary*

	Grouping	Pine	Cedar	Oak	Redwood
Group 4:	Primers, Sealers, and Undercoaters				
Product A2	H	1.93	3.64	4.89	6.98
Product B2	H	2.25	2.62	2.77	4.95
Product C2	L	3.99	4.03	4.44	6.08
Product D2	L	1.70	3.37	5.32	8.42

*Average Values

Grain Raising & Sandability Summary*

	Grouping	Grain Raising		Sandability	
		Oak	Pine	Oak	Pine
Group 4:	Primers, Sealers, and Undercoaters				
Product A2	H	1	2	Good	Good
Product B2	H	2	3	Good	Good
Product C2	L	1	2	Good	Good
Product D2	L	2	3	Good	Good

*Average Values

Enamel Holdout Summary*

	Group	20° Mean	20° SD	60° Mean	60° SD	85° Mean	85° SD
Group 4:	Primers, Sealers, and Undercoaters						
Product A2	H	12.9	0.7	51.9	1.0	53.7	0.7
Product B2	H	8.6	0.4	38.2	1.0	40.9	0.9
Product C2	L	7.7	0.4	37.7	1.3	42.1	1.1
Product D2	L	10.8	0.7	47.2	1.1	51.2	1.1
Standard							
Eco Brilliant		71.3	0.7	85.9	0.4	97.1	0.8

*Average Values

Flow/Level and Sag Summary*

	Grouping	Flow/Level	Sag
Group 4:	Primers, Sealers and Undercoaters		
Product A2	H	1	12+
Product B2	H	0	12+
Product C2	L	0	12+
Product D2	L	0	12+

*Average values

Tests for Waterproofing Concrete/Masonry Sealers Summary

Alkali, Acid, & Stain Resistance Visual Evaluation Summary*

	10% HCl	5%NaOH	Water	Motor Oil	Break Fluid	Transmission Fluid	Diesel Fuel
Group 5:							
Product E2	Slight Ring	None	None	None	None	Pink Stain	None
Product F2	White Powder	None	None	Stain and ppt**	Stain and ppt**	Stain and ppt**	Stain and ppt**
Product G2	Slight Yellow	None	None	Slightly Greasy	White Stain	Slight Pink Stain	Slight Yellow
Product H2	White Stain	Light Stain	Light Stain	Stain	Stain	Pink Stain	Stain
Product I2	White Stain	Light Stain	None	Stain	Stain	Pink Stain	Light Stain
Product J2	Bright White	Light Stain	None	Stain	Stain	Pink Stain	Light Stain
Product K2	White Stain	None	None	Stain	Stain	Light Stain	Very Light Stain

*Averages of visual inspections

**'ppt' means that a precipitate was formed on the surface

Alkali, Acid & Stain Resistance, Wine Spectrophotometer Evaluation Summary*

	X	Y	Z	ΔE
Group 5:	Concrete/Masonry Sealers			
Product E2	71.38/51.97	74.86/42.56	63.30/32.28	18.78
Product F2	42.75/33.52	44.89/34.39	41.45/29.62	8.53
Product G2	84.51/59.64	89.50/62.10	92.74/58.77	13.98
Product H2	38.04/28.36	39.76/29.16	35.29/23.95	8.79
Product I2	39.95/30.09	41.84/31.02	37.10/25.65	8.63
Product J2	41.84/23.13	44.04/23.56	42.74/19.68	17.83
Product K2	44.12/35.21	46.30/36.26	43.73/32.75	7.53

*Average Values; Left value is before staining, right value is after staining

Prohesion, Color Change (ΔE) Summary*

	Grouping	After 1 Cycle	After 2 Cycles	After 3 Cycles
Group 5:	Concrete/Masonry Sealers			
Product E2	H	2.04	1.88	1.37
Product F2	H	1.76	5.13	6.19
Product G2	L	0.47	0.60	0.62
Product H2	L	1.68	2.33	2.04
Product I2	L	1.36	2.67	3.37
Product J2	L	0.49	2.18	3.30
Product K2	H	1.67	1.60	3.04

*Average Values

Chloride/Nitrate Ion Screening Summary*

	Grouping	Chloride Level (ppm)	Nitrate Level (ppm)
Group 5:	Concrete/Masonry Sealers		
Product E2	H	0	5
Product F2	H	0	5
Product G2	L	0	5
Product H2	L	0	5
Product I2	L	0	5
Product J2	L	0	5
Product K2	H	0	5

*Average Values

Efflorescence Summary*

	Grouping	Rating
Group 5:	Concrete/Masonry Sealers	
Product E2	H	Slight
Product F2	H	Slight
Product G2	L	Slight
Product H2	L	Moderate
Product I2	L	Moderate
Product J2	L	Slight
Product K2	H	Slight

*Average Values

Water Vapor Transmission*

	Grouping	**Average Slope	***R² – 1	***R² – 2	***R² – 3
Group 5:	Concrete/Masonry Sealers				
Product E2	H	-0.01043	0.9883	0.987	0.9991
Product F2	H	-0.04657	0.9986	1	0.9997
Product G2	L	-0.03493	1	0.9877	1
Product H2	L	-0.0408	0.9999	0.9982	0.9987
Product I2	L	-0.04757	0.9973	0.9999	1
Product J2	L	-0.06157	0.9998	0.9967	0.9997
Product K2	H	-0.0568	0.9995	0.9998	0.9997
Standard	-----	-0.05117	0.9931	0.9988	0.9991

*Slopes of plots are averaged, all R² values shown

**The slope of the linear fit line is the mass lost per unit of time

***R² is a correlation factor for the linear fit line used to determine slope; an R² values of 1 is considered to be a perfect correlation, an R² value of 0.99 or greater is an eProduct C2lent fit, 0.98 or higher is a good fit, and 0.97 or below is a poor fit.

Tests for Exterior Stains Summary

Stain Resistance, Color Change (ΔE) Summary*

	Grouping	Ketchup	Mustard	Wine	Carbon Black
Group 6:	Exterior Stains				
Product L2	H	1.71	1.88	1.58	16.75
Product M2	L	0.99	1.12	0.99	33.92
Product N2	L	0.39	1.06	0.98	24.62
Product O2	L	0.54	3.12	0.82	25.63

*Average Values

Direct Adhesion on Wood (ASTM D3359) Summary*

	Grouping	Rating	Failure Mechanism
Group 6:	Exterior Stains		
Product L2	H	N/A – Solvent	N/A – Solvent
Product M2	L	4	Substrate Failure
Product N2	L	3	Substrate Failure/Stain Adhesion**
Product O2	L	3.7	Substrate Failure/Stain Adhesion**

*Average Values

**All these samples had both substrate cohesive failure and stain adhesion failure

Taber Abrasion Summary*

	Grouping	I (Wear Index)	L (Weight Loss, mg)
Group 6:	Exterior Stains		
Product L2	H	94.42	37.77
Product M2	L	194.25	77.70
Product N2	L	136.92	54.77
Product O2	L	33.33	13.33

*Average Values

QUV Summary – Color Change*

	Grouping	ΔE , 200 Hours	ΔE , 400 Hours	ΔE , 600 Hours	ΔE , 800 Hours	ΔE , 1000 Hours
Group 6:	Exterior Stains					
Product L2	H	22.82	22.92	22.24	21.36	20.61
Product M2	L	19.12	19.36	17.62	16.93	16.46
Product N2	L	8.71	10.43	13.58	15.62	18.50
Product O2	L	26.63	26.40	26.74	24.65	22.41

*Average values

QUV Summary – Gloss: 0 Hours / 1000 Hours*

	Group	20°Mean	20 SD	60°Mean	60 SD	85°Mean	85 SD
Group 6:	Exterior Stains						
Product L2	H	0.8/0.5	0.1/0.1	2.5/1.8	0.2/0.1	1.1/1.3	0.2/0.1
Product M2	L	0.8/0.5	0.1/0.1	2.2/2.5	0.2/0.2	0.7/1.5	0.1/0.1
Product N2	L	0.8/0.4	0.1/0.1	2.4/1.8	0.2/0.1	0.6/1.0	0.2/0.1
Product O2	L	1.5/0.8	0.2/0.1	9.7/5.1	1.5/0.5	5.2/4.2	1.0/0.4

*All values written as: left value = 0 Hours value, right value = 1000 Hours value

*All values are averages

Tests for Clear Wood Finishes Summary

Friction Coefficient Summary*

	Grouping	Friction Coefficient
Group 7:	Clear Wood Finishes	
Product P2	H	0.45
Product Q2	H	0.76
Product R2	L	0.30
Product S2	L	0.39
Product T2	L	0.30
Product U2	L	0.45

*Average Values

Stain Resistance Summary*

	Water, Visual	Vodka, Visual	Wine, ΔE	Carbon Black, ΔE
Group 7:	Clear Wood Finishes			
Product P2	None	None	1.76	1.57
Product Q2	None	None	2.20	14.62
Product R2	None	Slight Ring	0.60	0.81
Product S2	None	None	0.89	6.08
Product T2	None	Slight Ring	1.31	2.48
Product U2	None	Stain-Gloss Change	0.34	4.16

*Average Values

Mar Resistance*

	Grouping	Percent Gloss Retention
Group 7:	Clear Wood Finishes	
Product P2	H	72.49
Product Q2	H	80.29
Product R2	L	69.98
Product S2	L	79.20
Product T2	L	55.73
Product U2	L	76.79

*Average Values

Taber Abrasion Summary*

	Grouping	I (Wear Index)	L (Weight Loss, mg)
Group 7:	Clear Wood Finishes		
Product P2	H	50.50	20.20
Product Q2	H	66.75	26.70
Product R2	L	36.83	14.73
Product S2	L	20.92	8.37
Product T2	L	77.33	30.93
Product U2	L	65.75	26.30

*Average Values

QUV Summary – Aluminum, Gloss: 0 Hours / 1000 Hours*

	Group	20°Mean	20 SD	60°Mean	60 SD	85°Mean	85 SD
Group 7:	Clear Wood Finishes						
Product P2	H	44.6/5.0	1.2/0.9	85.1/9.6	1.5/2.4	86.9/27.7	0.8/2.9
Product Q2	H	125.8/113.3	1.1/3.0	125.5/123.7	1.3/1.4	97.4/92.7	1.5/1.0
Product R2	L	25.9/1.4	1.0/0.2	51.4/3.5	1.0/0.7	46.1/4.0	0.6/1.2
Product S2	L	30.5/15.1	1.3/1.3	59.5/33.7	1.7/1.7	62.9/38.2	2.5/1.4
Product T2	L	108.0/24.1	6.3/2.5	120.7/50.4	1.4/4.6	92.0/67.5	2.6/5.5
Product U2	L	46.7/2.1	2.1/0.3	77.0/4.2	1.8/0.5	76.3/3.5	1.4/0.4

*All values written as: left value = 0 Hours value, right value = 1000 Hours value

*All values are averages

QUV Summary – Pine, Gloss: 0 Hours / 1000 Hours*

	Group	20°Mean	20 SD	60°Mean	60 SD	85°Mean	85 SD
Group 7:	Clear Wood Finishes						
Product P2	H	14.5/6.5	1.6/2.0	54.0/38.8	2.1/4.2	65.7/66.8	3.1/1.3
Product Q2	H	36.3/17.8	7.9/4.1	76.4/49.9	2.5/4.2	79.8/53.1	2.1/2.0
Product R2	L	16.7/7.9	0.6/0.9	52.2/36.7	2.7/2.5	64.5/56.8	2.5/2.1
Product S2	L	10.9/6.9	0.5/0.5	42.0/31.0	0.8/1.4	59.7/45.7	1.0/2.1
Product T2	L	14.0/8.3	1.9/2.2	44.9/32.8	1.5/4.9	48.4/37.2	4.0/5.2
Product U2	L	4.3/5.0	1.0/2.7	21.2/28.4	1.5/6.1	24.9/36.8	1.9/4.2

*All values written as: left value = 0 Hours value, right value = 1000 Hours value

*All values are averages

QUV Summary – Aluminum, Color Change*

	Grouping	ΔE, 200 Hours	ΔE, 400 Hours	ΔE, 600 Hours	ΔE, 800 Hours	ΔE, 1000 Hours
Group 7:	Clear Wood Finishes					
Product P2	H	11.09	15.08	18.21	19.12	16.53
Product Q2	H	5.22	5.16	5.88	6.48	6.01
Product R2	L	4.68	4.77	5.29	10.54	4.70
Product S2	L	1.90	2.21	3.17	3.48	3.54
Product T2	L	0.33	1.99	3.36	9.39	4.84
Product U2	L	1.29	3.38	5.14	10.22	4.09

*Average values

QUV Summary – Pine, Color Change*

	Grouping	ΔE, 200 Hours	ΔE, 400 Hours	ΔE, 600 Hours	ΔE, 800 Hours	ΔE, 1000 Hours
Group 7:	Clear Wood Finishes					
Product P2	H	20.30	26.38	30.16	29.70	27.20
Product Q2	H	8.66	12.91	15.96	17.78	18.72
Product R2	L	20.77	24.43	27.49	23.53	26.74
Product S2	L	19.89	23.95	26.50	27.27	28.01
Product T2	L	23.30	28.06	29.78	31.40	31.35
Product U2	L	23.77	28.41	30.28	32.06	31.26

*Average values

Flow/Level and Sag Summary*

	Grouping	Flow/Level	Sag
Group 7:	Clear Wood Finishes		
Product P2	H	10	< 3
Product Q2	H	10	< 3
Product R2	L	8.3	< 3
Product S2	L	9	< 3
Product T2	L	10	< 3
Product U2	L	10	< 3

*Average values

Task 1 - Testing Protocol

Tests for General Properties of all paints

Property	Standard	Number of Replicates	Substrate	Film Thickness/ Bar Type
Percent Solids	ASTM D2369-04	3	N/A	N/A
Stability	ASTM D1849-95	1	N/A	3mil/Bird bar
Stormer Viscosity	ASTM D562-01	2	N/A	N/A
Cone and Plate Viscosity	ASTM D4287-00	2	N/A	N/A
Freeze-Thaw Resistance	ASTM D2243-95	3	N/A	3 mil/Bird bar
Dry Time - Mechanical	ASTM D5895-03	2	Glass	3mil Cube Applicator
Dry Time	ASTM D1640-03	2	Glass	3mil/Bird bar
Gloss	ASTM D523-89	2	Leneta Card 1-B	3mil/Bird bar
Hide	Spectrophotometer	4	Leneta Card 1-B	3mil/Bird bar 2mil/Bird bar

Tests for Primers, Sealers, and Undercoaters

Property	Standard	Number of Replicates	Substrate	Film Thickness/ Bar type
Adhesion Direct to Wood	Battelle Torque & ASTM D3359	3	Pine	Coated by weight
Overcoat Adhesion	Battelle Torque & ASTM D3359	3	Pine	Coated by weight
Stain Bleed Resistance	Our Protocol	3 (of each stain)	Drywall	3 mil/Bird bar
Tannin Stain Resistance	ASTM D6686-01	3	Pine, Cedar, Oak, Redwood	Coated by weight
Grain Raising	Our Protocol	2	Pine and Oak	Coated by weight
Sandability	150 grit visual rating	2	Pine and Oak	Coated by weight
Enamel Holdout	Our Protocol	3	Drywall	3mil/Bird bar
Flow & Leveling	ASTM D4062	3	Leneta Card 1-B	NPCA Bar
Sag Resistance	ASTM D4400-99	3	Leneta Card 1-B	Anti-Sag Meter

Tests for Waterproofing Concrete/Masonry Sealers

Property	Standard	Number of Replicates	Substrate
Alkali, Acid & Stain Resistance	ASTM D1308	3	Concrete
Prohesion	ASTM G85 Annex A5	2	Concrete
Chloride Ion Screening	CHLOR*TEST	2	Concrete
Efflorescence	ASTM D7072-04	3	Concrete
Water Vapor Transmission	ASTM D1653	3	Leneta

Tests for Exterior Stains

Property	Standard	Number of Replicates	Substrate
Stain Resistance	ASTM D4828 (modified)	3	Pine
Adhesion on Wood	ASTM D3359	3	Pine
Taber Abrasion	ASTM D4060	3	Birch
QUV	ASTM D4587	3	Pine

Tests for Clear Wood Finishes

Property	Standard	Number of Replicates	Substrate	Film Thickness/ Bar type
Friction Coefficient	ASTM D2047	4	Pine	3 coats by brush
Stain Resistance	ASTM D1308	3	Pine	3 coats by brush
Mar Resistance	ASTM D6037	3	Birch	3 coats by brush
Taber Abrasion	ASTM D4060	3	Birch	3 coats by brush
QUV	ASTM D4587	2	Aluminum, Pine	Wirewound, 3 coats by brush
Flow & Leveling	ASTM D4062	3	Leneta Card 1- B	NPCA Bar
Sag Resistance	ASTM D4400-99	3	Leneta Card 1- B	Anti-Sag Meter

Performance of Testing

Tests for General Properties of All Paints

Percent Solids – ASTM D2369 is used.

Stability – ASTM D1849 is used with one sample of each being kept at 125°F for 30 days, followed by evaluation as indicated in the standard. Gloss measurements will also be taken of the samples during evaluation.

Stormer Viscosity – ASTM D562, method B, is used and provides a digital readout in KU.

Cone & Plate Viscosity – ASTM D4287 is used with the Brookfield CAP2000 model viscometer, using a number 3 spindle and a shear rate of 1200s⁻¹.

Freeze-Thaw Resistance – ASTM D2243 is used for the water-borne paints for three samples of each with the paints applied to black and white Leneta charts after one, three, five, and eight cycles. A cycle is defined according to the ASTM method.

Dry Time – Mechanical Recorder – ASTM D5895 is used to determine dry time with a mechanical straight line drying time recorder.

Dry-Time – ASTM D1640 is used to determine dry time at room temperature.

Gloss – ASTM D523 is used with a BYK-Gardner micro-TRI-gloss meter calibrated just prior to use.

Hide – For dry hide and gloss, a three-mil Bird bar was used to apply paint to two black and white Leneta charts. Also, for hide, a two-mil Bird bar was used to apply paint to two black and white Leneta charts. The color was measured using a Minolta CM-2002 spectrophotometer and the CIE XYZ value for Y was recorded. The Y values over the white section and the black section were used to calculate dry hide. Due to Beer's and Lambert's Law, hide increases as film thickness increases. Hide also increases as concentration of hiding pigments increases.

Tests for Primers, Sealers, and Undercoaters

Adhesion Direct to Wood – The Battelle torque method and ASTM D3359 – Method B are used. The Battelle torque method measures the amount of parallel force required to break adhesion rather than perpendicular force (which the PATTI method measures). The coatings are applied by weight at the calculated spread rate to the substrate (wood) and allowed to dry for 7 days. The coating is then lightly sanded with 320 grit paper and a puck is adhered to the surface with an epoxy. The epoxy is allowed to dry for 24 hours and then the puck is removed with a digital torque wrench which converts torque to pounds per square inch (psi). ASTM D3359-Method B is also used to determine adhesion. This method uses a cutting tool and 3mm cutting guide to make a series of perpendicular cuts in the surface. Pressure sensitive tape in accordance with the ASTM procedure is then applied and removed after 90 seconds and the adhesion is qualitatively analyzed based on how much coating was removed by the tape.

Overcoat Adhesion – The Battelle torque method and ASTM D3359 – Method B are used. A red tinted Sherwin Williams ProMar 200 is used as the topcoat to evaluate the adhesion of a latex

paint to the primer on wood. The Battelle torque method measures the amount of parallel force required to break adhesion rather than perpendicular force (which the PATTI method measures). The coatings are applied by weight at the calculated spread rate to the substrate (wood) and allowed to dry for 7 days. The coating is then lightly sanded with 320 grit paper and a puck is adhered to the surface with an epoxy. The epoxy is allowed to dry for 24 hours and then the puck is removed with a digital torque wrench which converts torque to pounds per square inch (psi). ASTM D3359-Method B is also used to determine adhesion. This method uses a cutting tool and 3mm cutting guide to make a series of perpendicular cuts in the surface. Pressure sensitive tape in accordance with the ASTM procedure is then applied and removed after 90 seconds and the adhesion is qualitatively analyzed based on how much coating was removed by the tape.

Stain Bleed Resistance – Our protocol is used. Stain Bleed Resistance evaluates the ability of the coating to cover existing stains. Seven stains are applied in fixed amounts to drywall: lipstick, red crayon, grape juice, mustard, instant coffee, hot pink highlighter, carbon black. The stains are allowed to dry 24 hours, and then are top-coated with a 3mil drawdown of the primer/sealer/undercoater. The coatings are allowed to dry for 7 days and then are evaluated for color change using the Minolta CM-2002 spectrophotometer.

Tannin Stain Resistance – ASTM D6686-01 is used. This test evaluates a primer's ability to resist tannin bleed-through from wood substrates. Pine, cedar, oak, and redwood are used as the substrates. The panels are coated by weight, allowed to dry 24 hours in ambient conditions, and then are dried for two weeks at 50°C. The panels are then evaluated for color change relative to a leneta chart drawdown.

Grain Raising – Our protocol is used. Grain raising is an evaluation of the roughness of a coating after application over wood. To evaluate grain raising, pine and oak panels are sanded with 120 grit sandpaper and the dust is removed with a tack cloth. After 48 hours of equilibration, the panels are coated by weight and allowed to dry 48 hours before evaluation. The panels are evaluated for roughness by both visual and tactile ratings. The rating scale is: 1 (No grain raising, smooth and uniform), 2 (Slight grain raising, detectible visual/tactile surface grain), 3 (moderate grain raising, very visible/tactile), 4 (moderately severe, increased size of grain), and 5 (severe grain raising, very large grain, highly visible and obvious).

Sandability – A 150 grit visual rating is used. The sandability test is an evaluation of how well a coating responds to sanding after being applied to a wood substrate. The grain raising panels were used for the sandability test after grain raising evaluation. The panels were evaluated as to paper gumming (poor sandability) or powdering (good sandability).

Enamel Holdout – Our protocol is used. Enamel holdout evaluates how much the primer/sealer/undercoater affects the gloss of an applied topcoat. The primer/sealer/undercoater is applied to drywall using a 3mil drawdown bar. After 24 hours, the topcoat is cross-drawn (a drawdown perpendicular to the primer) and allowed to dry 7 days before gloss evaluation. The topcoat used is Eco Brilliant. A comparison is then made between the gloss of the topcoat over the primer and the gloss of the topcoat alone on a standard leneta chart.

Flow & Leveling – ASTM D4062 is used. This is an old ASTM method that is analgous to the New York Society for Paint Technology "Official Digest" No. 44 Vol. 32, No. 430, p. 1435. The NYPC Level Blade is used.

Sag – ASTM D4400 is used. A Leneta anti-sag bar is used to apply paint to a black and white Leneta chart. This bar deposits strips of paint from 3 to 12 mils thick approximately ½” wide. The chart is immediately lifted to a vertical position with the 12 mil thick strip at the bottom. Evaluation is based upon how much the strips flow into the strips below.

Tests for Waterproofing Concrete/Masonry Sealers

Alkali, Acid & Stain Resistance – ASTM D1308-02 – Covered Spot Test Method is used. The stains evaluated are acid (10% HCl), alkali (5% NaOH), distilled water, wine (spectrophotometer evaluation), motor oil, break fluid, transmission fluid, and diesel fuel. The concrete panels are coated with the sealers at the recommended spread rate and allowed to dry for 7 days. The panels are then stained with 1mL of each staining media. The stain is then covered with a watch glass. After 24 hours, the watch glass is removed and the stain is wiped with a clean paper towel and a very small amount of slightly soapy water. The panels are then allowed to dry and are evaluated for stain. All evaluations are visual except for the wine, which is evaluated with the Minolta CM-2002 Spectrophotometer.

Prohesion – ASTM G85 Annex A5 is used. The concrete panels are coated and allowed to dry for 7 days. The panels then undergo alternating exposure for two weeks per cycle. The first week of the cycle is 7 days in UV testing – 4 hours of UV, 4 hours of humidity. The second week of the cycle is 7 days in the salt fog chamber – 1 hour salt fog, 1 hour dry. After a full cycle (2 weeks), the panels are evaluated for color change with the Minolta CM-2002 Spectrophotometer. A total of 3 cycles are completed.

Chloride Ion Screening – The CHLOR*TEST is used. This test was developed by CHLOR*RID International and is an evaluation of the amount of chloride ions that is able to leach through the coating to the surface from the concrete. A nitrate test is also included. For more information: http://www.chlor-rid.com/chlor_test.htm .

Efflorescence – ASTM D7072-04 is used. This test uses green concrete (concrete that has not fully cured) which has been allowed to dry for 48 hours from when it was made. The concrete is then coated and dried for 24 hours. The coating is then placed in a constant humidity chamber for 48 hours. Upon removal, the coatings are evaluated for efflorescence.

Water Vapor Transmission – ASTM D1653 is used. This test evaluates how well a coating seals by measuring the transmission of water through the coating by weight per unit time. Copy paper is used as the substrate. For the penetrating coatings, a piece of paper for each coating is saturated with the coating. For the top-coat sealers, a 2mil drawdown is made on the paper. Three circles per paint are cut from the paper. The water permeability cups are filled with water and the paper is mounted in the holder, along with wax coated rings to seal it, and clamped in position. The cups are immediately weighed. After specific intervals, the cups are weighed until multiple data points are collected (4-6 data points). This data is then evaluated and graphed.

Tests for Exterior Stains

Stain Resistance – ASTM D4828 is modified for this test. This method is actually a washability test and provides information about the changes which occur as a result of sponge cleaning a stained area rather than the coating’s likelihood of resisting a stain. To better determine the coating’s resistance to staining, the coating is applied to three pine panels and allowed to dry for 7 days as described in the ASTM method. Color is measured on each panel using a Minolta CM-

2002 spectrophotometer and the CIE XYZ values are recorded. Four staining materials, ketchup, mustard, wine and carbon black, are applied with each panel having one stripe of each for a total of 4 stripes per panel, and 3 stripes of each stain per coating. The materials are left on the panels for 24 hours and then rinsed with de-ionized water and washed for 100 cycles manually with non-abrasive cleaner and a sponge according to the ASTM method. The panel is patted dry with paper towels to remove standing water, and is then allowed to air dry for one day. Then, color measurements are taken of the stripes with CIE XYZ values and ΔE values recorded.

Adhesion on Wood – ASTM D3359 is used. This method uses a cutting tool and 3mm cutting guide to make a series of perpendicular cuts in the surface. Pressure sensitive tape in accordance with the ASTM procedure is then applied and removed after 90 seconds and the adhesion is qualitatively analyzed based on how much coating was removed by the tape.

Taber Abrasion – ASTM D4060 is used. Birch Taber panels were used as the substrate and are coated and allowed to dry for 7 days. The coated panels are then run for 400 cycles with CS-17 wheels on a Taber Abraser. The weight loss due to abrasion is evaluated as a measure of abrasion resistance.

QUV – ASTM D4587 is used. The pine panels are subjected to UV and condensation cycles alternating every four hours. Every 200 hours total time, the panels are evaluated for gloss and color change and are rotated according to the standard used. The total time used is 1000 hours.

Tests for Clear Wood Finishes

Friction Coefficient – ASTM D2047 is used to determine the coefficient of friction of the coatings with a James Machine.

Stain Resistance – ASTM D1308-02 – Covered Spot Test Method is used. The staining media used are distilled water, wine, carbon black, and 50:50 ethanol:water (vodka equivalent). The panels are coated and allowed to dry for 7 days. The panels are then stained with 1mL of each staining media. The stain is then covered with a watch glass. After 24 hours, the watch glass is removed and the stain is wiped with a clean paper towel and a very small amount of slightly soapy water. The panels are then allowed to dry and are evaluated for stain. The water and vodka evaluations are visual and the wine and carbon black evaluations are done with the Minolta CM-2002 Spectrophotometer.

Mar Resistance – ASTM D6037 is used. Birch Taber panels are coated and allowed to dry and equilibrate. The gloss of the un-abraded panels is taken at 20° and the panels are abraded for 10 cycles. The gloss of the abraded panels is then recorded. The difference between the gloss readings is used to determine percent gloss retention.

Taber Abrasion – ASTM D4060 is used. Birch Taber panels were used as the substrate and are coated and allowed to dry for 7 days. The coated panels are then run for 400 cycles with CS-17 wheels on a Taber Abraser. The weight loss due to abrasion is evaluated as a measure of abrasion resistance.

QUV – ASTM D4587 is used. The aluminum and pine panels are subjected to UV and condensation cycles alternating every four hours. Every 200 hours total time, the panels are evaluated for gloss and color change and are rotated according to the standard used. The total time used is 1000 hours.

Flow & Leveling – ASTM D4062 is used. This is an old ASTM method that is analgous to the New York Society for Paint Technology “Official Digest” No. 44 Vol. 32, No. 430, p. 1435. The NYPC Level Blade is used.

Sag – ASTM D4400 is used. A Leneta anti-sag bar is used to apply paint to a black and white Leneta chart. This bar deposits strips of paint from 3 to 12 mils thick approximately ½” wide. The chart is immediately lifted to a vertical position with the 12 mil thick strip at the bottom. Evaluation is based upon how much the strips flow into the strips below.