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Indexed

Marshall Laboratory
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3/25/52

MEMORANDUM REPORT NO. M-429

BLISTERING OF TRIM & SHUTTER PAINTS

Investigation WT-164

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Introduction:

Blisters occasionally form in the field shortly after repainting with Trim and Shutter colors. Invesitgation WT-164 requests that the Trim and Shutter colors be improved in blister resistance. However, we have been unable to improve the blister resistance or to reproduce the blistering but in this report we have summarized the data from complaints received from the field and have characterized the blistering. Attempts to reproduce blistering are listed. We believe any further work should be done under a project.

Summary and Conclusions:

The blistering generally occurs over previously painted wood, and often forms under previous coats. Several instances of previous blistering are reported. Our products may not be directly responsible for blistering and every effort should be made on every future complaint to investigate the bond and the presence of blisters under old coats.

A change in the formula will probably not overcome all complaints. Those products which contain ammonium stearate solution and develop high temperatures on exposure seem to be the most subject to complaint.

Blisters may be formed from a pressure increase of air due to a temperature rise, together with very poor or no adhesion. So-called sun or solvent blistering is probably just the delayed air expansion lifting of a previous moisture blister failure.

Temperatures attained in the sun by Brown and Black are the highest and can be as much as 32°F. higher than the shade temperature.

The Brown leads in frequency of complaints. Dark Green

Details:

Field Experience:

35 complaints on blistering of Trim and Shutter have been reviewed to characterize the blistering. The following conclusions are drawn. (See Table I)

1. Blistering generally occurs over previously painted wood.

	# of Complaints
Over previously painted paint films	24
Unreported	9
New wood	2*

2. Blistering is probably due to poor bond of the previous coats.

	# of Complaints
Lifting of previous coats	9
Blistering over new wood	1*
Lifting of topcoat or coats only	1*
Unreported	24

*In one of these tests the blisters were comparatively small and are more on the order of pimpling. The other was tissue paper peeling.

3. More thorough investigation might show previous blistering in the history of most complaints as 4 instances of previous blistering were reported voluntarily or because the salesman had detected some very obvious previous failure.

4. Slight pressures which are developed by temperature differences acting on a volume of air sealed within the painted object may be enough to overcome the poor bond and raise a blister. One customer reports that blisters would rise during the day and fall at night. Blisters have been reported on wood but not on metal sections of the same job.

5. Painting indoors and outdoors, at high temperatures and at low temperatures, in spring, summer and fall and in all of the states of the Philadelphia region were reported in complaints.

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6. The role of poor bond of previous coats should be investigated thoroughly in every future complaint in the field because poor bond of previous coats will relieve our product of some responsibility and the information acquired will set the course of research in the proper direction,

7. Complaints are totaled as follows:

Color	Complaint Reports	% of Total	Sales of Color on Percentage Basis
Dark Green	14	48%	42%
Brown	8	28	8
Maroon	2	7	2
Light Green	2	7	21
Jade Green	1	3	4
Black	1	3	16
Red	1	3	3
Blue	0	0	4
Total	29	100%	100%

Intermixes and no colors.

No color mentioned	1
Green & Black Intermix	3
Brown & Black "	1
Light & Dark Green Intermix	1
	35

80% of the complaints are on colors which develop high temperatures and contain ammonium Stearate Solution.

8. Possible reasons why Brown and Dark Green lead in frequency of complaints and account for 28% and 48% of complaints respectively are:

(a) They are popular colors which have sold 8% and 42% of Trim & Shutter postwar sales.

(b) They have been sold since 1946.

(c) They may have been more extensively used for recoat work than the Blue, Red & Maroon.

(d) They develop high temperatures on exposure.

(e) They contain water to improve application properties. (See Table II)

Statements A, B, C, D can be said about Black
" A, B, C, E " " " " Lt. Green

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Cause of Blisters:

Blisters should not form within the wet paint film because the partial pressure of water and heavy petroleum solvent are not equal to atmospheric pressure at 49°C. (120°F.). The partial pressure of water is 88 mm. of Hg or .11 atmospheres. The partial pressure of H-200 or H-287 exerted at this temperature would be about one-thirtieth of the water vapor pressure, since they boil at 100°C. higher. In order to do expansion work against the atmosphere, the absolute pressure must be greater than one atmosphere.

If air is present in a nearly deflated previous blister or in air cells in the wood, the water vapor and temperature can increase the total volume 20% at atmospheric pressure during a rise from 60°F. to 120°F.

Although we suspect water in the paint to be a contributing factor, water vapor can be supplied by the wood also during a temperature rise.

Equilibrium Temperature in the Sun:

Thermometers painted with T. & S. colors give the following average temperatures in Florida:

Brown	116.2°
Black	113
Dk. Green	111
Blue	110
Jade Green	108
Light Green	108
Red	108
Uncoated	100
Shade	87

Differences are significant at 95% probability except between Dark Green and Blue.

Heat absorption may be a contributing factor as the brown which leads in frequency of complaints develops the highest temperature on exposure to sunlight.

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Trim & Shutter Production:

Code	Color	1951	1950	1949	1948	1947	1946	Total	% of Total
87-102	Lt. Green	32,194	36,930	26,876	21,594	52,627	38,321	208,707	21
87-103	Dk. Green	82,220	80,229	63,227	55,208	74,314	56,335	413,017	42
87-208	Jade Green	15,304	6,191	3,603	14,479	6	20	39,603	4
87-682	Brown	19,719	19,481	13,840	19,215	10,231	103	82,589	8-1/2
87-696	Blue	8,093	9,138	8,147	-	-	-	25,378	2-1/2
87-047	Red	9,403	10,664	12,805	-	-	-	32,872	3-1/2
87-001	Black	30,940	27,296	28,097	32,246	18,996	14,003	152,214	16
87-751	Maroon	4,261	13,925	6,580	-	-	-	24,766	2-1/2

The new colors, Red, Blue and Maroon, have only yielded a few complaints. Customers tend to repaint the same color and the bright colors, Red, Blue & Maroon may have been used primarily on new construction. If blistering doesn't develop until several coats are built up, we may begin to get more complaints on Blue, Red & Maroon in the next few years.

Reproducing Blisters:

Tests which we have tried are listed in Table III for the record. None reproduce blisters of the type generally encountered in the field.

MARSHALL LABORATORY

W. C. Johnson

W. C. JOHNSON

WCJ:hfm
3/3/52

ATTACH:

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TABLE I

	Customer's Name	Date Painted	Product	Date of Prev. Paint	Previous Coat	Where Painted	°F. Temperatures	Primer	State	Months to Failure	Objects Painted	Sales Dept. #	Remarks
1	Sobel	8/15/51	T & S Blk.	-	-	-	-	#40 O.W.	-	1	-	51-785	
2	Thompson Mahogany	Fall 1950	T & S Dk. Green	1946	T&S Green	Outside	-	-	-	7	Wood Trim	51-182	
3	Binder	March 1950	T & S Dk. Green	1949	Green put on by builder	"	Normal March 1950	-	Pa.	12	Shutter & Trim	51-284	
4	Rosbi	-	T & S Blk. & Green	1942	T & S Blk. & Green	Indoors	-	T & S Under.	N.C.	-	Shutters	51-404	Shutters in good condition
5	Kimball	-	T & S Dk. Green	1942	Orthodox Ivory	Does not say	Cool weather	"	N.C.	-	"	51-324	Old, previously blistered etc.
6	Mixon	7/18 to 7/28/49	T & S Dk. Green & Blk.	1942	T & S	Indoors	95°	T & S Green & Blk.	N.C.	1/2	"	51-368	
7	Lehman	Fall 1949	T & S Lt. Green	-	-	Does not say	-	-	Md.	-	"	51-741	
8	Hubor	1949	T & S Dk. Green	-	Previously painted	-	-	Undercoat	N.Y.	2 yrs.	Trim	51-932	Previous trouble
9	Foecster	April 1951	Dk. Green	-	Green paint	Outside	Normal April	-	"	6	Shutters	51-1028	
10	Upshur	July & Oct.	Blk. & Dk, Green	-	Yes	Indoors & Outdoors	Hot & Dry		Va.	-	-	-	Previous trouble on wood but not on metal
11	Fisher	July 1951	Maroon	-	Yes	-	-	-	N.J.	1/2	Trim	51-654	Shown to be moisture blistering
12	Pastore	Oct. 1950	Maroon	1946	Pittsbrugh	-	60°	Maroon	N.Y.	1	Body	51-158	Saleman says it does not seem to be moisture blister

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TABLE I

	Customer's Name	Date Painted	Product	Date of Prev. Paint	Previous Coat	Where Painted	°F. Temperatures	Primer	State	Months to Failure	Objects Painted	Sales Dept. #	Remarks
13	Lubuch	Spring	Brown	-	-	-	-	-	Pa.	6	Trim	51-953	8-10 coats are blistering.
14	Cobey	6/51	Brown	1948	Brown	Outside	65-75°	-	Conn.	2	All trim	51-986	
15	Pedut	10/51	Brown	1948	Brown	Outside	-	-	N.Y.	2	-	51-1150	Previous trouble
16	Economy	1948	Red	-	New	Outside	-	-	-	2 yrs.	Trim & doors	50-374	Tissue paper peeling of top-coat only
17	Niebrehr	April 1949	T&S Green	-	Yes	Outside	-	#40	N.Y.	13	-	50-297	
18	Gray	May 1950	Green	-	-	-	-	-	Va.	-	-	50-409	
19	Benner	-	Lt. Green	-	-	-	High	-	Pa.	-	Picnic table	50-588	
20	Marvin	Fall 1948	Brown	1946	T&S Brn.	Outside	-	Under-coat	Pa.	-	Siding	50-347	
21	Weinstein	Late Spring	Brown	-	Unknown	Outside	-	-	Pa.	-	Trim	50-862	Blistered down to bare wood
22	Graff	April 1948	Dk. Green	1944	Brittle	Outside	-	-	Wash., D.C.	-	-	49-51	Prev.coating loses bond
23	Ackerman	-	Dk. Green	-	-	-	-	-	-	-	-	49-161	
24	Seller	Spring 1948	" "	-	Linseed Oil	Brown Outside	-	-	Pa.	13	Trim	49-534	
25	Wolberg	May 1949	Lt. & Dk. Green	-	Yes	-	-	T & S	Md.	1	Trim	49-330	Many coats blistering loose
26	Sherwood	Easter 1949	Dk. Green	-		Inside	-	-	N.Y.	2	-	49-291	All paint down to bare wood
27	Chard	Nov. 1949	" "	-	Yes	Outside	-	-	Pa.	-	-	49-770	Pimples
28	Cartright	Spring 1949	Jade	5 yrs. prev.	T & S Lt.Grn.	Outside	-	-	N.J.	-	-	49-593	

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TABLE I

	Customer's Name	Date Painted	Product	Date of Prev. Paint	Previous Coat	Where Painted	°F. Temperatures	Primer	State	Months to Failure	Objects Painted	Sales Dept. #	Remarks
29	Ruzonski	Fall 1949	-	-	Yes	Outside	-	-	Pa.	-	Porch	49-745	Picked up the old paint into blisters
30	Matthews	-	Brown	-	Several	-	-	-	N.J.	-	Trim	48-140	Separation between previous coats of paints
31	Burton	9/5/51	Blk & Brn.	-	Aged	-	55-80	-	-	-	-	-	Blisters down to wood
32	Graves	Oct.	Dk. Green	-	New	-	50-55	-	-	-	-	-	Small blisters
33	Memphis Store	Oct. 1951	Brown	-	-	-	-	-	-	-	-	-	
34	Dwaskins	Oct. 1951	Dk. Green	-	-	-	-	-	-	-	-	-	
35	Stephen Robey	Dec. 1950	Brown	-	-	-	-	-	-	-	-	-	

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TABLE II

Composition

Code	87-102	87-103	87-208	87-001	87-047	87-696	82-682	87-751
Color	Lt. Green	Dk.Green	Jade Green	Black	Red	Blue	Brown	Maroon
348-18323 Soap & water soln.	19#/100 gal.	19	20	-	-	-	16	-
VM-7790 Soya Lecithin	27#/100 gal.	26	-	-	-	-	24	-
VD-7750 Cobalt Drier	-	-	10#/100 gal.	16	8	1	9	-
Resin	Soya/PE	Soya/PE	L.O./Glyc.	Soya/Glyc.	L.O./ Glyc.	Soya/ Glyc.	Soya/ PE	L.O./ Glyc.
Gallons of water vapor/gal. paint as 348-18323	29	29	30	-	-	-	25	-

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TABLE III

Tests Tried to Develop Blisters

Code	Color	Doctor Blade Application	Substrate	Test	Blistering
87-103	Dk. Green	.0042 mils	Bare maple	Dried under UV light	Craters to 1/4" Diameter
87-696	Blue	"	"	"	Few pinpoint
87-102	Lt. Green	"	"	"	"
87-001	Black	"	"	"	"
87-102	Lt. Green	"	Outside White on cedar	"	"
87-103	Dk. Green	"	"	"	"
87-047	Red	.0056	Bare white pine	"	"
87-682	Brown	"	"	"	"
87-102	Lt. Green	.0042	Panel wetted & dried overnight	"	Many pinpoint
87-001	Black	"	"	"	"
87-102	Lt. Green	Brushed	Outside White on cedar	"	None
87-001	Black	"	"	"	"
87-103	Dk. Green	.0042	Bare maple	Dried in 120° oven	"
87-696	Blue	"	"	"	"
87-103	Dk. Green	"	"	Under fan 15" Dry under UV	Few pinpoint
87-696	Blue	"	"	"	"
87-103	Dk. Green	"	"	Panel pre-heated	"
87-696	Blue	"	"	"	"
87-103	Dk. Green	"	Steel	3x348-18323 added dried under UV	"

The pinpoint blisters are very small and would hardly be cause for complaint. They might be bubbles of air trapped in the film when applied.

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