STATE OF OKLAHOMA
DEPARTMENT OF TRANSPORTATION
RESEARCH AND DEVELOPMENT DIVISION

FINAL REPORT
Project No. 2722

EVALUATION OF COATINGS APPLIED OVER CORRODED STRUCTURAL STEEL SURFACES

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16. ABSTRACT

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The coatings tested were: (1) Freecom, Corroseal FOC 54/55, an epoxy one-coat system, (2) DuPont, 25P/Imron, an epoxy base coat with a polyurethane top coat, (3) Praxis, Prax-Ten, a penetrant base coat and a concentrate top coat of metal alkyl sulfonates, (4) Tenemec, series 135/74, an epoxy base coat with a polyurethane top coat, and (5) Black Gold, a hydrocarbon sealer base coat with an aluminum flake top coat in a hydrocarbon and solvent binder.

The best performing coating was the one supplied by DuPont. The Tnemec coating also performed well and ranked second. The Praxis coating ranked third. The poorest performing coating was Black Gold. The Corroseal coating performed better than Black Gold on the pre-corroded panels, but disbonded from the clean surfaces before the end of the testing period.

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INTRODUCTION

Environmental health and safety concerns dictate the containment and recovery of debris generated by sand blasting to remove paint containing lead and chromate primers from bridges and other steel structures. This requirement markedly increases the costs of maintenance painting where the steel must be sand blasted down to bare metal to remove rust. Coatings or pretreatments that could be applied to a rusty or contaminated steel surface without prior sand blasting would considerably reduce the costs of repainting. Although a number of specialty coatings reputedly provide corrosion protection when applied over rusted surfaces, there is only limited data to support such claims.

The object of this investigation was to evaluate a number of commercial coatings that are intended for application on highway bridge steel that is rusty and is less than abrasively blast cleaned. The performance of these coatings was to be compared with that of coatings applied in the conventional manner over abrasively cleaned surfaces.

Five coating systems were evaluated. The five coatings were those provided by DuPont, Freecom, Praxis, Tnemec, and Tri-F. These coatings were applied to both pre-corroded and non-corroded steel test panels. The evaluation consisted of exposing the coated test panels in a salt fog environment for a period of 50 days with daily inspection of the coatings. What follows is a report on the test program and the test results.

COATING MATERIALS

The coating materials were provided by suppliers who had made contact with the State of Oklahoma, Department of Transportation (ODOT), concerning the application of their product as a bridge coating for the conditions of use described above. A list of the suppliers is contained in Appendix A. A description of the coatings obtained from information provided by the suppliers is contained in Appendix B. The coating names were Corroseal from Freecom, Inc., DuPont 25P and Imron from DuPont Company, Prax-Ten from Praxis Technologies, Inc., Endura-Shield IV and Chembuild from Tnemec Company, and Tri-F Black Gold from Fred F. Foster, Inc. For purposes of this study the coatings are identified by the single names Corroseal, DuPont, Praxis, Tnemec, and Black Gold.

TEST PROCEDURES

Panel Surface Preparation

The coatings were applied to both pre-corroded and non-corroded steel surfaces. The test panels were "Q" panels, 4 in x 6 in x 0.32 in thick with a dull matte finish. The panels were grit blasted before processing with "Zero Blasting" glass beads, BT-10, size range 100-170 mesh. Panels were pre-corroded by exposure in a salt fog chamber constructed for this project. The chamber test conditions conformed to ASTM B-117, except that the test temperature was ambient (23^{o}C). The uncoated panels were exposed for 216 hours (9 days). This produced a thick but non-uniform rust. These samples were dried for 7 days, and then the loose scale was removed in accordance with SSPC procedure SP2, Hand Tool Cleaning. The condition of the panels in the as-received, grit blasted, corroded, and hand cleaned conditions are shown in Figure 1.

Coating of Panels

The panels pre-corrroded and cleaned as described above and the non-corroded panels, which were merely grit blasted, were then coated according to the suppliers specifications as listed in Table I. Coatings were applied with an air sprayer. The suppliers' recommendations for mixing and thinning were followed. Coatings were applied to the recommended dry film thickness. This was accomplished by calculating the wet film thickness for the desired dry film thickness. Then measurements were made of the wet film thickness during coating application.

Comments on the ease of application are included in Table I. All of the epoxy coatings were quite viscous and required greater skill in application than the other coatings, especially when the mixture contained a high solids content. The DuPont base coating, 25P, required the most care in application, since it did not atomize easily in the air sprayer. Apparently, the epoxy fluids must have a high viscosity to keep solids in suspension.

Cure time between coats of the two-coat systems was 48 hours unless a shorter time was specified. Only DuPont and Tnemec provided cure time recommendations. All coatings were cured for a minimum of 7 days before beginning the salt fog exposure test. This is in accord with NACE recommended practice RP-02-81.

Some of the coatings were cut with a scribe before testing. The scribing tool and procedure were as described in ASTM D 1654-84. Table II summarizes the panel treatments and indicates the number of panels prepared with each treatment, i.e., non-corroded or pre-corroded, type of coating, number of coats, and scribed or non-scribed. Panels labeled as "reference" were saved for comparison with those subjected to the salt fog test.

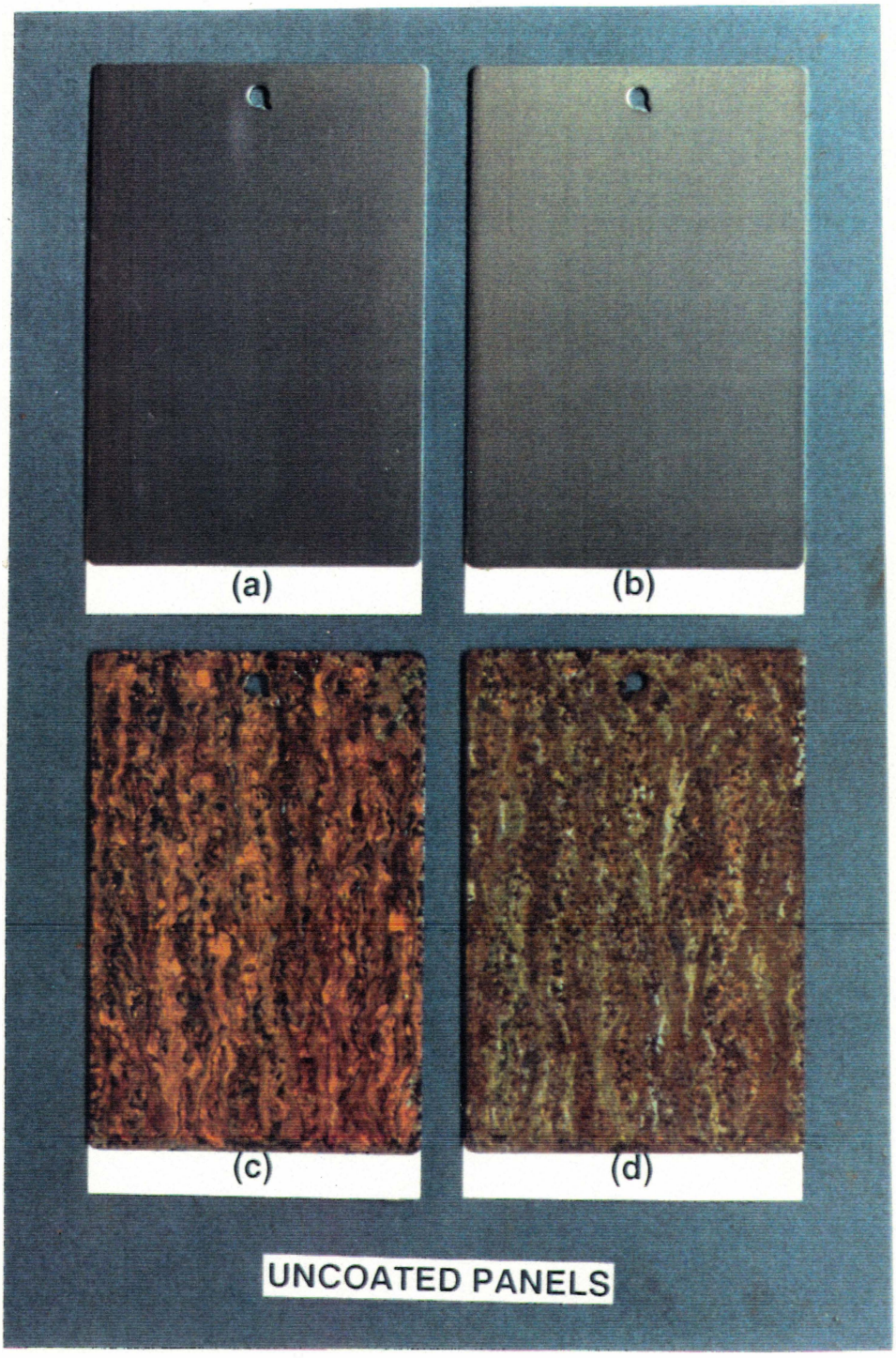

Figure 1: Test panels surface appearance before coating applications: **(a)** panel without any treatment, **(b)** grit blasted only, **(c)** grit blasted and pre-corroded, and **(d)** grit blasted and pre-corroded followed by hand tool cleaning.

Table I

Mixing and Application Specifications for Coatings

	Du Pont		Freecom, Inc.	Praxis		Tnemec		TRI-F (Black Gold)	
	25P	IMRON 326	Corroseal	Prax-Ten Penetrant	Prax-Ten Concentrate	Series 135 Chembuild	Series 74 Endura-Shield	Metal Sealer	Aluminum Paint
Mixing Preparation									
-Part (A:B)	1:1	4:1	4:1	1 part	1 part	4:1	4:1	1 part	1 part
--A,ml	75	30	50	--	--	50	50	--	--
--B,ml	75	120	200	--	--	200	200	--	--
--TOTAL,ml	150	150	250	--	--	250	250	--	--
--% Thinner	20	0	15	none	none	15	10	none	none
--Thinner type	MEK	--	MEK	none	none	No.19(Tnemec)	No.24(Tnemec)	none	none
--% Solids	70	30	90	50	70	82	67	NA	NA
--Pot Life,hr	0	16	4-6	NA	NA	4	2	NA	NA
---Temp.°,°f	70-90	70	70	NA	NA	77	77	NA	NA
Coating Description									
-Color	Aluminum	Cirrus Grey	Grey	Clear (Yellowish)	Grey	Grey	Brown	Black	Aluminum
-Material Type	Epoxy Mastic	Polyurethane Enamel	Epoxy	Metal Alkyl Sulfonates	Metal Alkyl Sulfonates	Epoxy	Acrylic Polyurethane Enamel	NA	NA
-% Solids	70	30	90	50	70	82	67	NA	NA
Applied Thickness									
--Wet, mil	9	5	4	2	2	8	5	2	2
--Dry, mil	6	2	2	1	1	6	3	<1	1
Applied Coating Finish									
--Appearance	not Smooth	Gloss	Gloss	Smooth	Smooth	Smooth	Gloss	Smooth	Smooth
--Dried Finish	Hard	Hard	Hard	Soft & Sticky	Soft & Sticky	Hard	Hard	Soft & sticky	Slightly
--Comment	Does not atomize easily, applies as dry	Easy to apply	Very easy to apply	Easy to apply as thin coat	Easy to apply as thin coat	Easy to apply	Very easy to apply	Easy to apply both as only thin coats	

Table II

Panel Coating Treatments

Coating Supplier and Type Applied	No. of Coats	Panel Treatment: Pre-Corroded* — Testing: Not Scribed	Pre-Corroded* — Testing: Scribed	Pre-Corroded* — Reference: Not Scribed	Pre-Corroded* — Reference: Scribed	Non-Corroded* — Testing: Not Scribed	Non-Corroded* — Testing: Scribed	Non-Corroded* — Reference: Not Scribed	Non-Corroded* — Reference: Scribed
TRI-F (Black Gold)									
-Metal Sealer (base)	1								
-Aluminum Paint (top)	1								
—TOTAL	2	2	2	1	0	2	2	1	1
Du Pont									
-25P (base)	1								
-IMRON 326 (top)	1								
--TOTAL	2	2	2	2	0	2	2	1	1
-only 25P	1								
--TOTAL	1	0	0	0	0	2	2	1	1
Freecon, Inc.									
-Corroseal	1								
--TOTAL	1	2	2	1	0	2	2	1	1
Praxis Technologies, Inc. (Prax-Ten)									
-Penetrate (base)	1								
-Concentrate (top)	1								
--TOTAL	2	2	2	1	0	2	2	1	1
Tneaec									
-Series 135 (base)	1								
-Series 74 (top)	1								
--TOTAL	2	2	2	1	0	2	2	1	1

*Number of test panels coated for each treatment

Coating Exposure Test

The coated panels were placed in test racks within the salt fog chamber. The racks are horizontal and test panels sit in slots in the rack inclined at 15 degrees from the vertical. Panel locations in the racks are displayed in Table III. There were two racks with two rows of panels on each rack. The coatings were randomly distributed on a rack, but all of the scribed panels were on one rack and all of the non-scribed panels were on the other rack. The panels were coded for purposes of identification with the coding scheme listed in Table IV. This coding scheme was used in recording data on visual examinations of the panels.

During the period of testing, 50 days, the panels were examined once each day. The examination consisted of removing the panels from the chamber and allowing them to dry for 15 to 20 minutes and then inspecting them visually. The panels were then returned to the chamber for another 24 hours.

The visual examination was used to assign coating ratings for Blister Size, ASTM D 714-87, Blister Frequency, ASTM D 714-87, Rust Rating, ASTM D 610-85, and Scribe Rating ASTM D 1654-84. These rating scales are summarized in Table V.

TEST RESULTS

The daily visual observations on the panels throughout the 50 days of testing in the salt fog chamber were recorded. These data for each panel were plotted versus time. These graphs are presented in Appendix C in Figures C1 through C10. There were duplicate panels for each of the 4 test conditions for each of the 5 coatings. For the unscribed panels the blister size, frequency, and rust rating were recorded. For the scribed panels, blister size, frequency, and scribe rating were recorded. This makes a total of 24 plots for each coating, a total of 120 for the 5 coatings.

After the test program was completed, the test panels were allowed to dry for about 30 days. Then the test panels, along with the reference (untested) panels, were photographed in color. These photographs are presented as Figures 2-6.

The visual observation data in Appendix C were consolidated for easier inspection by averaging the replicate data and plotting blister size, frequency, and rust rating for the unscribed panels, and only the scribe ratings for the scribed panels. These summary data for all 5 coatings are presented in Figures 7-10. Blister size is plotted in Figure 7, Blister Frequency in Figure 8, Rust Rating in Figure 9, and Scribe Rating in Figure 10.

Table III

Coatings Identified by Tray Position in Salt Fog Chamber

Column	Non Scribed		Scribed	
Row	A	B	C	D
1	DuPont (2 coat)			DuPont (2 coat) PC
2	DuPont (1 coat)	Corroseal PC	Corroseal	Black Gold PC
3				
4	Prax-Ten PC	Prax-Ten	Tnemec PC	DuPont (1 coat)
5		DuPont (2 coat) PC		
6	Corroseal PC	Black Gold PC	Prax-Ten	Tnemec
7				
8	Black Gold	Tnemec PC	Black Gold	Corroseal PC
9			DuPont (2 coat) PC	
10	Tnemec	Prax-Ten PC	Corroseal	Prax-Ten PC
11	DuPont (2 coat)			DuPont (2 coat)
12	DuPont (1 coat)	Corroseal	Tnemec	Prax-Ten PC
13			DuPont (2 coat)	
14	Black Gold PC	Tnemec	Prax-Ten	Tnemec PC
15		DuPont (2 coat) PC		
16	Corroseal	Prax-Ten	DuPont (1 coat)	Corroseal PC
17				
18	Tnemec PC	Black Gold	Black Gold	Black Gold PC

*Two trays are used for positions A, B, C and D. The scribed B panels are separate in one tray. The non-scribed B panels are separated into a different tray.

Table IV

Explanation of Panel Identification Numbers

Panel Identification Indentification Number	Tray Location		Pretreatment Description	
	Column	Row	Panel	Coating
A1-GBON	A	1	Grit blasted only	Non-scribed
B2-GBPN	B	2	Grit blasted only & precorroded**	Non-scribed
C3-GBOS	C	3	Grit blasted only	Scribed
D4-GBPS	D	4	Grit blasted only & precorroded**	Scribed

* Sample explanation of test panel identification only.
**After panels were precorroded, the surface of the panels were handtool cleaned.

Table V

Standard Coating Rating Scales

Standard	Scale	Description
ASTM D714-56	Size of Blister	
	10	No blister
	8	Pinpoint
	6	Pinpoint to 1/16 inch
	4	1/6 inch
	2	3/8 or larger
	Frequency of Blister	
	10	None
	8	Few
	6	Medium
	4	Medium-Dense
	2	Dense
ASTM D610-68	Rust Rating	
	10	No rusting or less than 0.01% of surface rusted
	9	Minute rusting, less than 0.03% of surface rusted
	8	Few isolated rust spots, less than 0.1% of surface rusted
	7	Less than 0.3% of surface rusted
	6	Extensive rust spots, bu less than 1% of surface rusted
	5	Rusting of the extent of 3% of surface rusted
	4	Rusting to the extent of 10% of surface rusted
	3	Approximately 1/6 of surface rusted
	2	Approximately 1/3 of surface rusted
	1	Approximately 1/2 of surface rusted
	0	Approximately 100% of surface rusted
ASTM D1654	Scribe Rating	Failure at Scribe, inch
	10	0
	9	0 - 1/64
	8	1/64 - 1/32
	7	1/32 - 1/16
	6	1/16 - 1/8
	5	1/8 - 3/16
	4	3/16 - 1/4
	3	1/4 - 3/8
	2	3/8 - 1/2
	1	1/2 - 5/8
	0	5/8 +

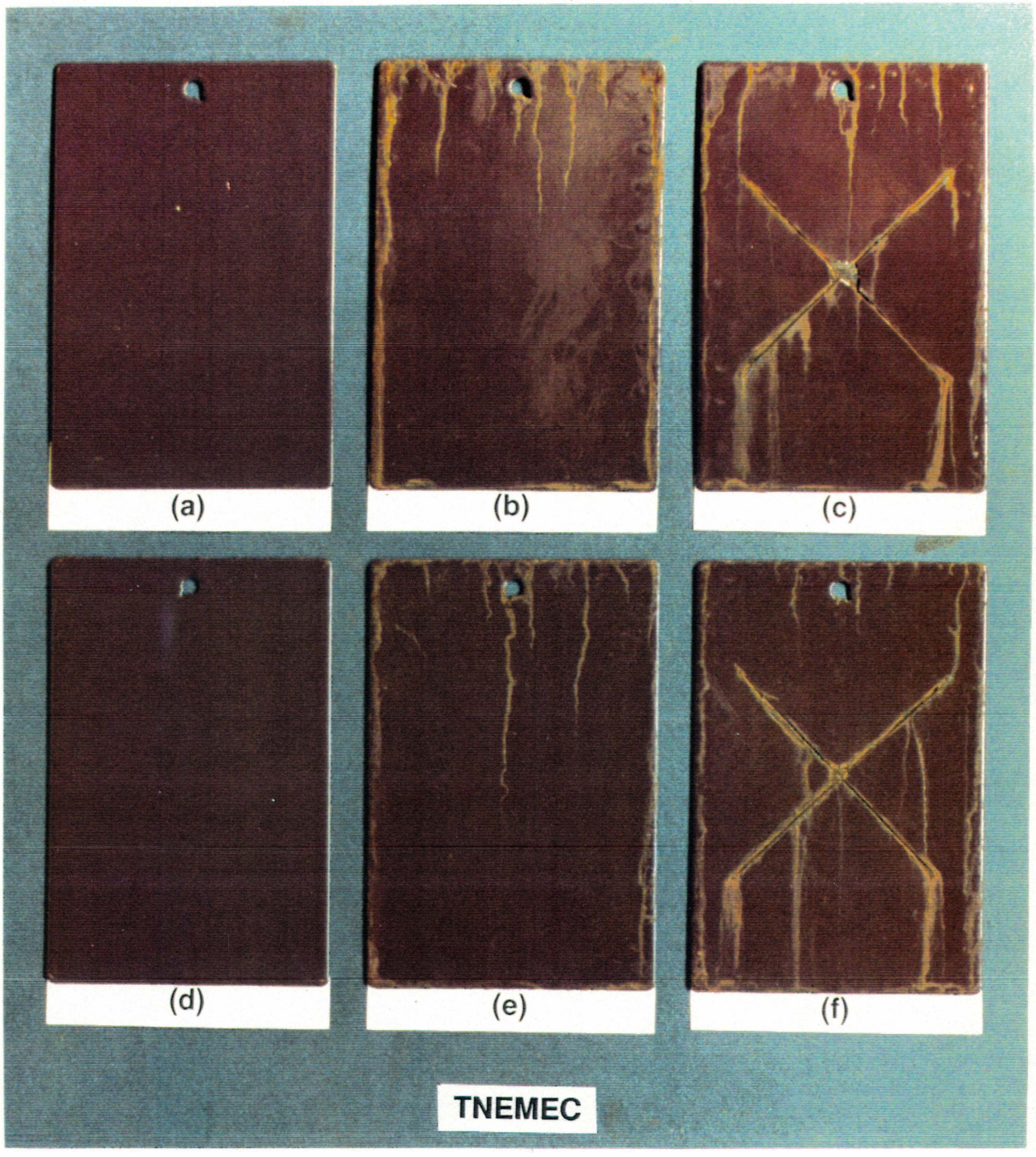

Figure 2: Coatings exposed to salt fog environment applied on surfaces prepared by: **(a,b,c)** grit blasting only, and **(d,e,f)** grit blasting followed by pre-corrosion and hand tool cleaning. Reference panels **(a)** and **(d)** illustrate the coating conditions before exposure.

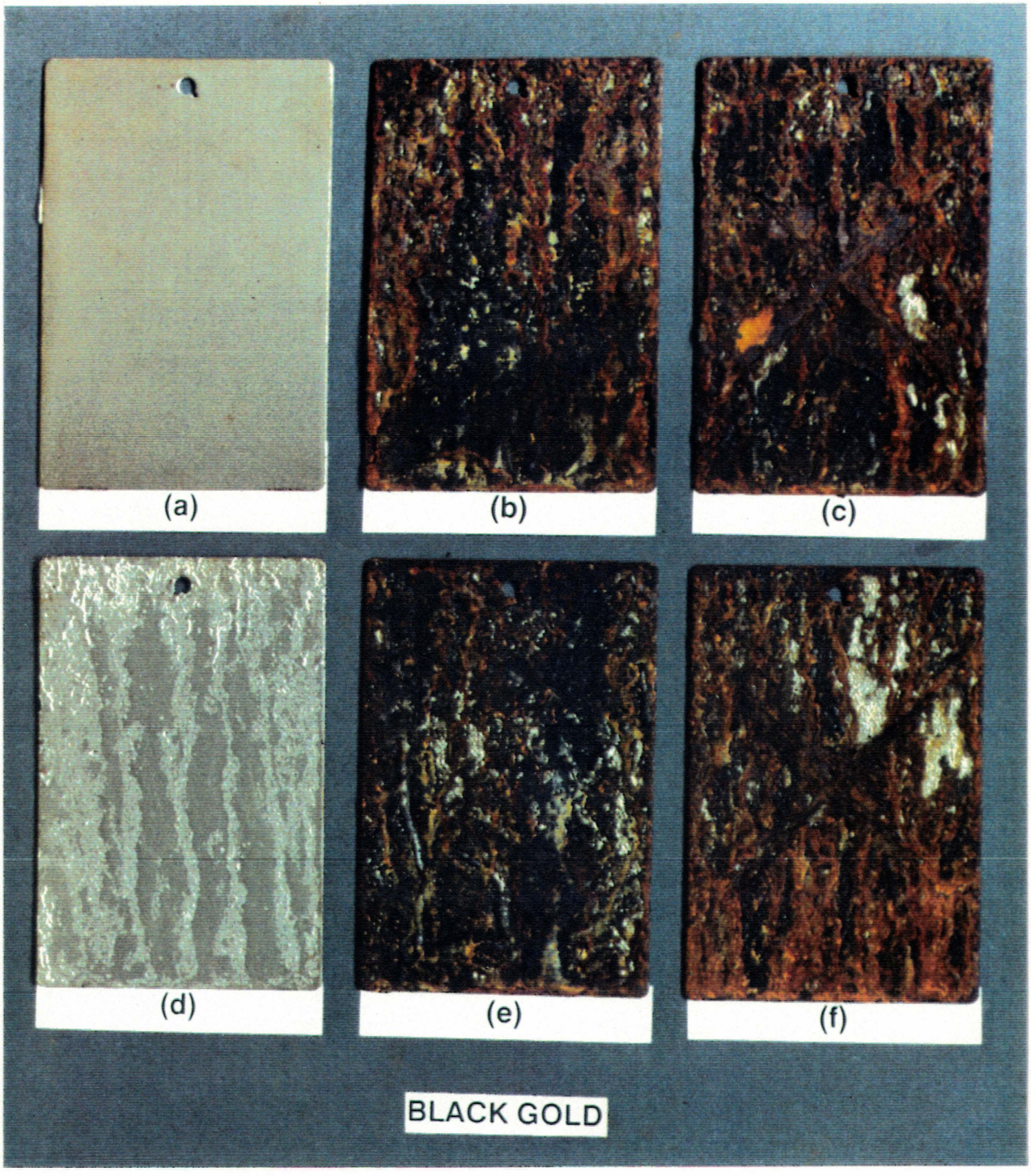

Figure 3: Coatings exposed to salt fog environment applied on surfaces prepared by: **(a,b,c)** grit blasting only, and **(d,e,f)** grit blasting followed by pre-corrosion and hand tool cleaning. Reference panels **(a)** and **(d)** illustrate the coating conditions before exposure.

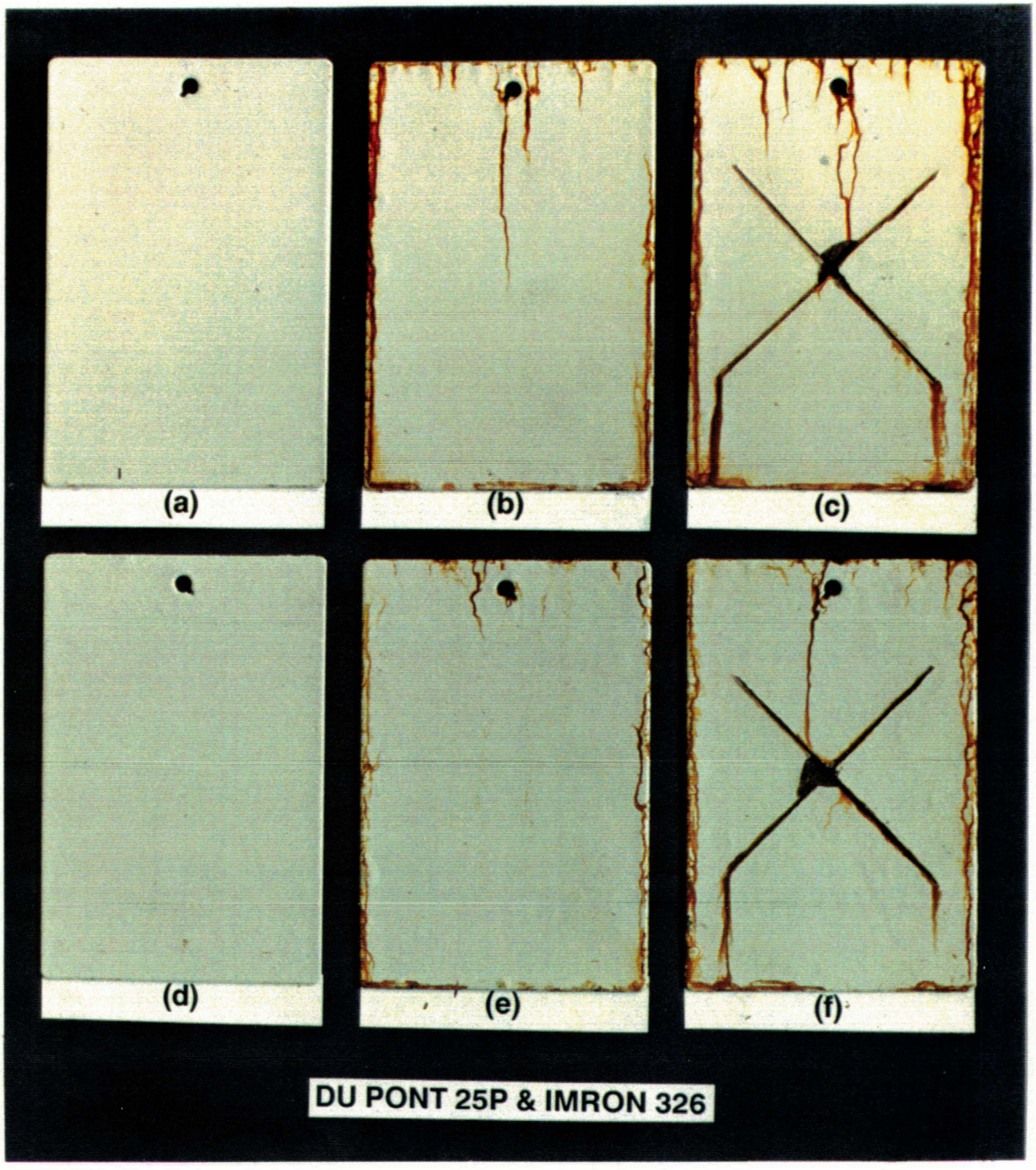

Figure 4: Coatings exposed to salt fog environment applied on surfaces prepared by: **(a,b,c)** grit blasting only, and **(d,e,f)** grit blasting followed by pre-corrosion and hand tool cleaning. Reference panels **(a)** and **(d)** illustrate the coating conditions before exposure.

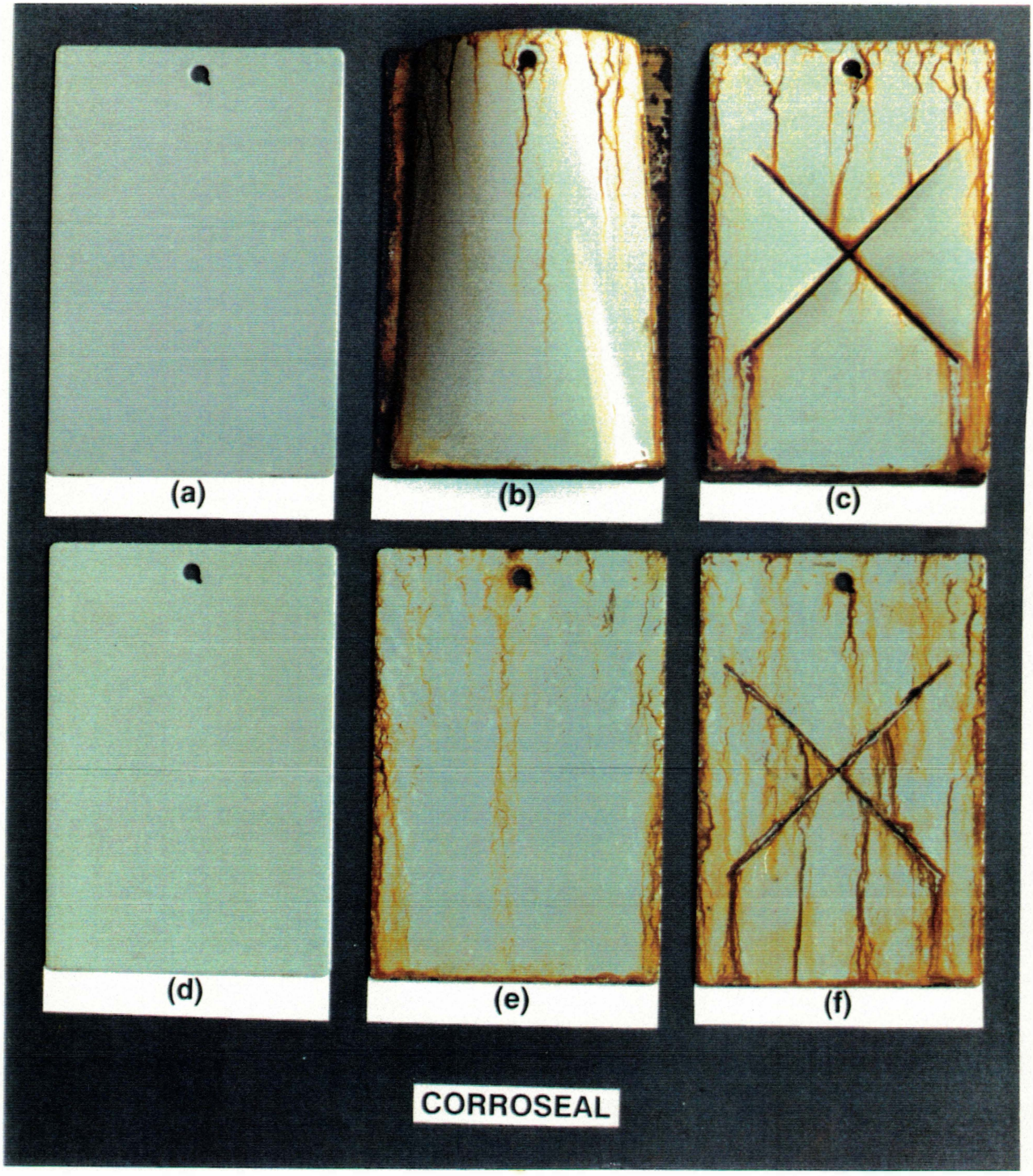

Figure 5: Coatings exposed to salt fog environment applied on surfaces prepared by: **(a,b,c)** grit blasting only, and **(d,e,f)** grit blasting followed by pre-corrosion and hand tool cleaning. Reference panels **(a)** and **(d)** illustrate the coating conditions before exposure.

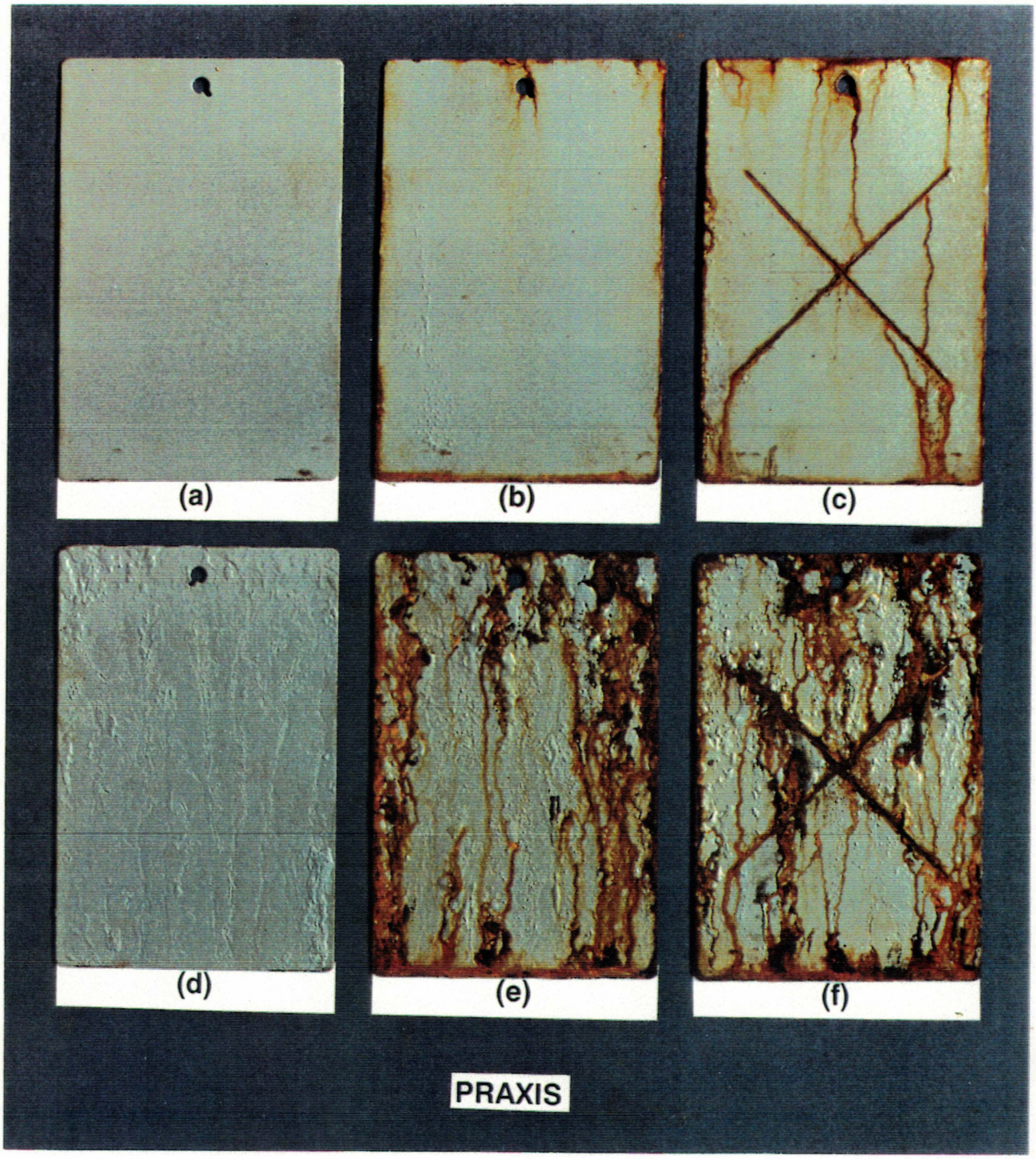

Figure 6: Coatings exposed to salt fog environment applied on surfaces prepared by: **(a,b,c)** grit blasting only, and **(d,e,f)** grit blasting followed by pre-corrosion and hand tool cleaning. Reference panels **(a)** and **(d)** illustrate the coating conditions before exposure.

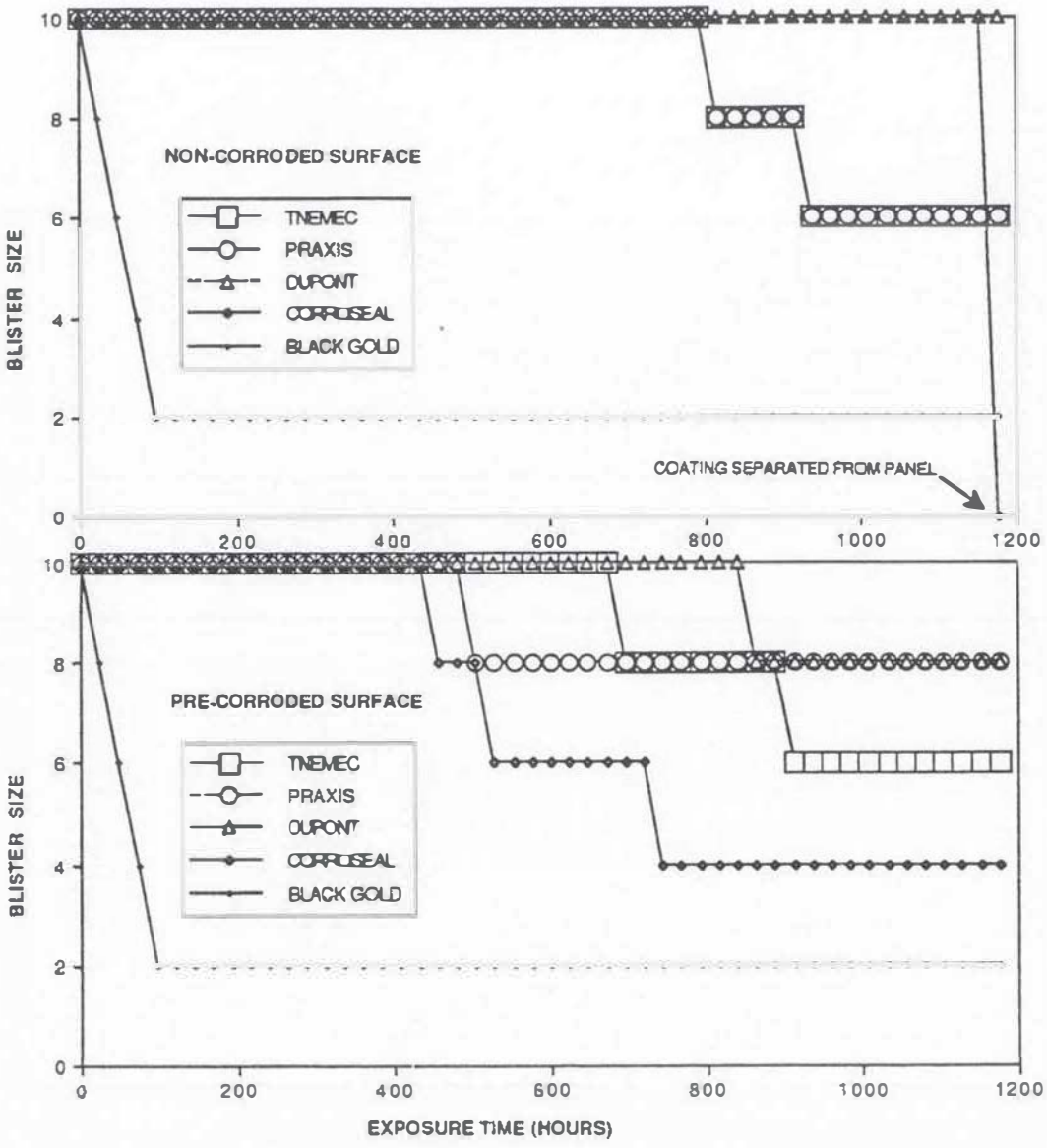

Figure 7. Blister size vs. exposure time in salt fog chamber for the five test coatings on (a) non-corroded and (b) pre-corroded panel surfaces.

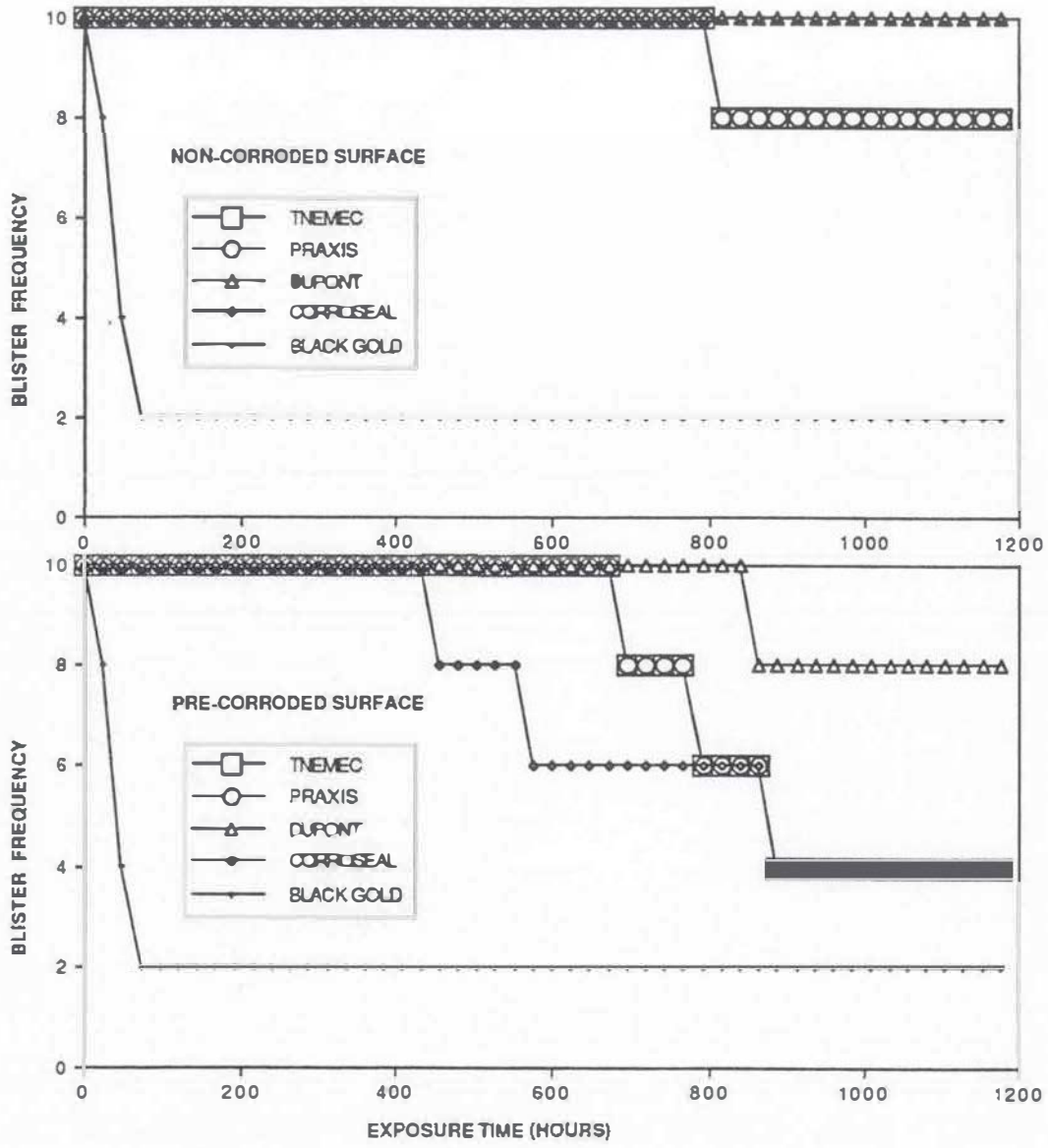

Figure 8. Blister frequency vs. exposure time in salt fog chamber for the five test coatings on (a) non-corroded and (b) pre-corroded panel surfaces.

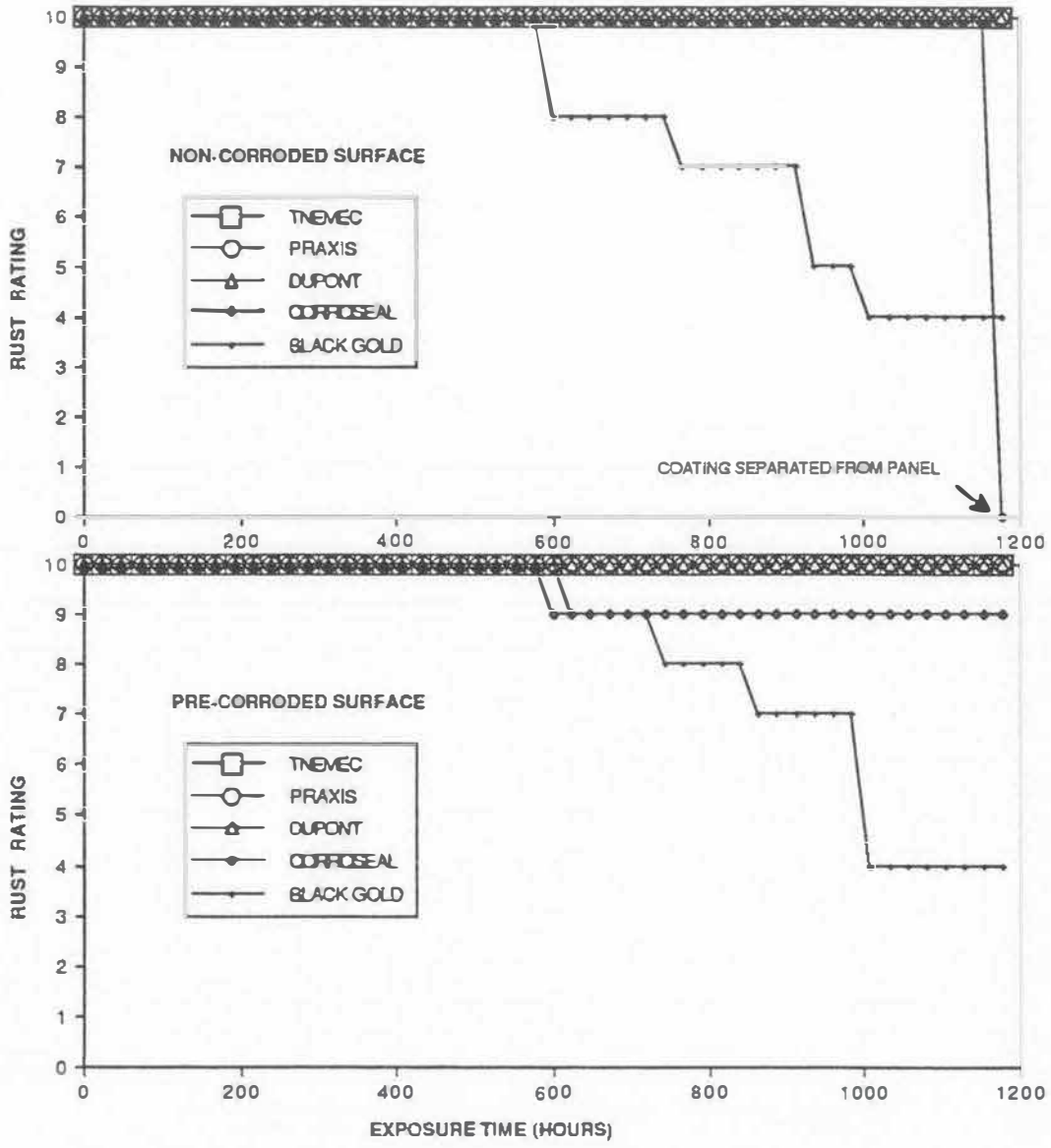

Figure 9. Rust Rating vs. exposure time in salt fog chamber for the five test coatings on (a) non-corroded and (b) pre-corroded panel surfaces.

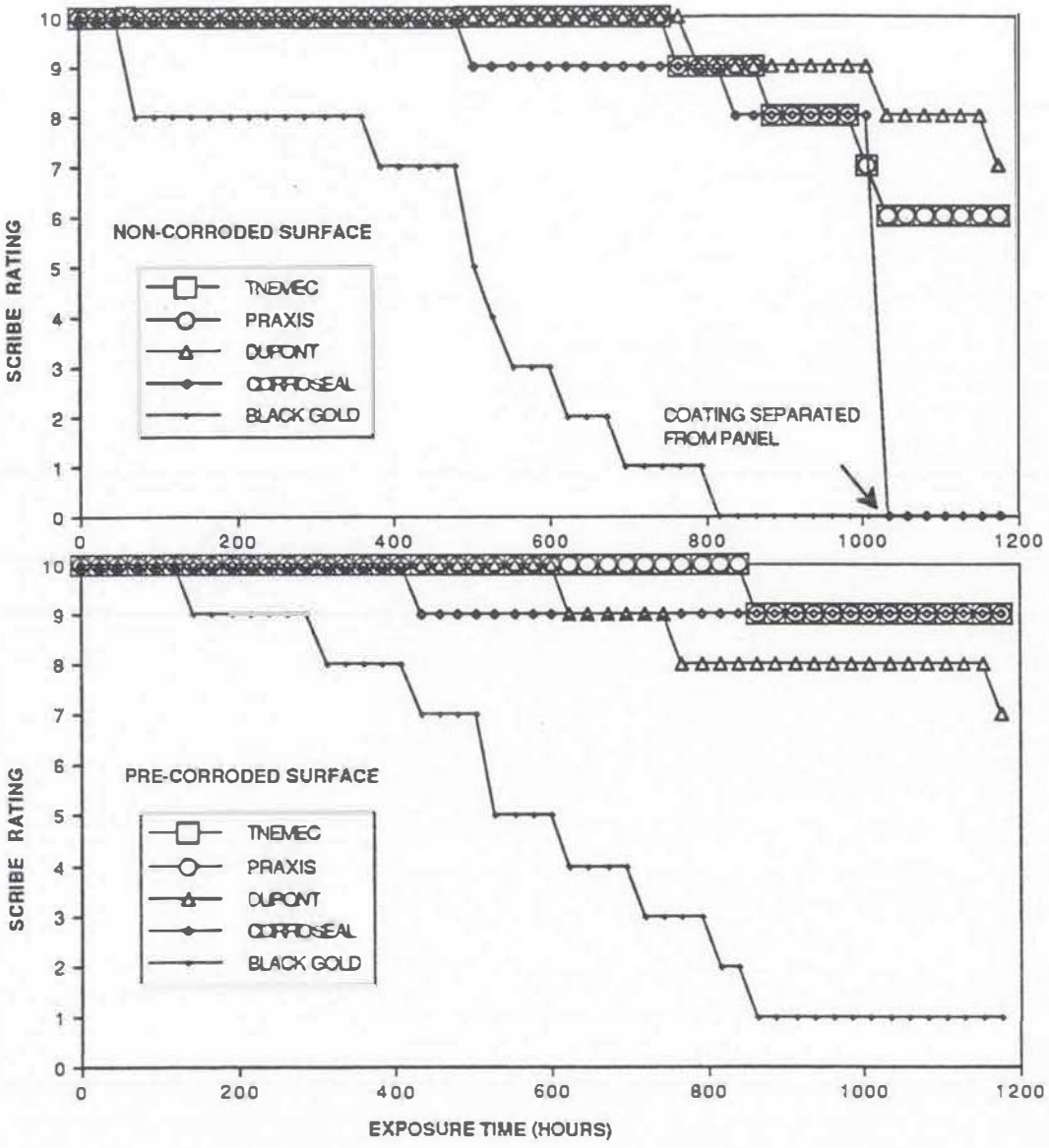

Figure 10. Scribe rating vs. exposure time in salt fog chamber for the five test coatings on (a) non-corroded and (b) pre-corroded panel surfaces.

DISCUSSION OF RESULTS

Tnemec Coating

The Tnemec coating, Figure 2, performed well on the scales of blister size and blister frequency on the non-corroded surface. Small blisters developed after about 800 hours. On the pre-corroded surface blisters developed after about 700 hours. The blister size rating was 6 and the frequency rating was 4 at 1200 hours. This corresponds to pinpoint to 1/16 inch blisters with a medium-dense frequency. The rust rating remained 10 for the 1200 hours of test. The scribe rating of the pre-corroded surface was 9 at 1200 hours, which was better than that of the non-corroded surface which degraded to 6 after about 1000 hours.

Black Gold Coating

The Tri-F Black Gold coating, Figure 3, was one of the thinner coatings, so the roughness of the pre-corroded surface shows through the coating (see Figure 3, panel d). The coatings on both the non-corroded and the pre-corroded surfaces began to blister after 24 hours of salt fog exposure. After 96 hours the coatings were densely blistered. Both blister size and blister frequency were at a rank of 2, i.e., 3/8 inch and larger blisters and dense blistering. The rust rating degraded markedly after 600 hours for both the non-corroded and pre-corrroded surfaces. The scribe rating began to degrade after 100 to 150 hours. On all four scales of comparison the performance of the Black Gold was inferior to that of the other coatings.

DuPont Coating

The DuPont coating, Figure 4, performed quite well on the scales of blister size and blister frequency. The coating on the non-corroded surfaces exhibited no blistering after 1200 hours. The coating on the pre-corroded panels showed some blistering after 800 hours, but degraded only to a rating of 8 on both the blister size and frequency scales. This represents a few pinpoint blisters. The non-scribed panels exhibited no rusting. The scribe rating for the non-corroded panels was good with creepage from the scribe of less than 1/64 inch after 1000 hours. The pre-corroded panels showed undercutting after 600 hours, but performed as well as the non-corroded panels with a scribe rating of 7.

Corroseal Coating

The Corroseal coating, Figure 5, on the non-corroded surface performed quite well with blister size and frequency ratings of 10 up to near the end of the test period. At about 1150 hours the entire coating disbonded from the surface as can be seen in Figure 5, panel (b). The coating on the pre-corroded surface did not disbond, but it developed blisters after about 425 hours. The blister size rating degraded to 4 after 750 hours and the

blister frequency degraded to 4 after about 875 hours. This represents medium-dense blistering up to a size of 1/6 inch. The rust rating was 10 for the coating on the non-corroded surface and 9 for the pre-corroded surface. The scribe rating was good, a 9, for the coating on the pre-corroded surface after 1200 hours. On the non-corroded surface, the scribed coating disbonded after about 1050 hours, so the scribe rating went to zero. Apparently, Corroseal bonds better to a rusted surface than to a clean surface.

Praxis Coating

The Praxis coating, Figure 6, was a thin coating, about 2 mil dry film thickness. The coating applied over the pre-corroded surface was rough (see Figure 6, panel d). On the non-corroded surface blistering began after about 800 hours. Blister size was 6 and blister frequency 8 after 1200 hours. This corresponds to a few blisters from pinpoint to 1/16 inch in size. On the pre-corroded surface the coating began to blister after about 475 hours, but blister size rating remained 8 throughout the test. Blister frequency increased with time reaching a level of 4 after about 850 hours. This corresponds to medium-dense, pinpoint blisters. The rust ratings of the coatings on both the non-corroded and the pre-corroded surfaces were recorded as a 10 throughout the test. However, these observations were apparently in error. Examination of the panels (as indicated in Figure 6) after completion of the tests showed extensive rusting through ruptured blisters and flaked coating. A rust rating no better than 6 is appropriate for the pre-corroded panels after 1200 hours of exposure. The scribe rating was better on the pre-corroded surface than on the non-corroded surface.

CONCLUSIONS

The study succeeded in establishing clear distinctions in the performance in a salt fog test of the several coating systems evaluated. This is a severe test and certainly not a substitute for long term coating exposure tests on structures exposed to the natural environment. However, the test has relevance in that it is discriminating, i.e., some coatings behaved well and others poorly.

The best performing coating was the DuPont coating followed in performance by the Tnemec coating. The DuPont and Tnemec coatings are thick film epoxies. The DuPont base coat, with a high solids content, coat was difficult to apply with the air sprayer.

The Praxis coating was ranked a distant third in performance. Praxis is a thin waxy coating and had a rough appearance on the pre-corroded surface.

The poorest performing coating was Black Gold. The coating blistered on both the non-corroded and the pre-corroded surfaces in a short period of time.

The Corroseal coating blistered more than DuPont, Tnemec, and Praxis on the pre-corroded surface, but was much superior to Black Gold. The Corroseal appeared to bond better to the pre-corroded surface than non-corroded surface. Since the coating disbonded from the clean surface during the test, its performance must be considered unsatisfactory.

RECOMMENDATIONS

Although the epoxy based coating systems, DuPont and Tnemec, performed well in this study, further investigation is needed into the ease of application and costs of these thick film systems relative to other systems.

The better performing coatings in this study, DuPont and Tnemec, should be considered for field testing on pre-corroded steel surfaces. They should be compared with coatings presently used by ODOT.

Additional coatings should be considered for laboratory salt fog testing, including coatings currently used by ODOT on cleaned steel surfaces.

APPENDICES

APPENDIX A. COATING SUPPLIERS

1.	Corroseal	Freecom, Inc., P. O. Box 2119, Big Spring, TX 79721 (915) 263-8497
2.	DuPont 25P and Imron	Maintenance Finishes, DuPont Company, Wilmington, DE 19898 (800) 346-4748
3.	Prax-Ten	Praxis Technologies, Inc., 901 Society Place Newton, PA 18940 (215) 860-5240
4.	Endura-Shield IV and Chembuild	Tenemc Company, Inc., P.O. Box 411749, Kansas City, MO 64141 (816) 483-3400
5.	Black Gold	Tri-F, Fred F. Foster, Inc. 1917 South Eastern, Oklahoma City, OK 73129 (405) 670-1973

APPENDIX B. COATING DESCRIPTIONS

Information provided by suppliers

1. Corroseal

Material obtained:	Corroseal, FOC 54/55, Ceramic Coating, Parts A and B.
Material description:	Epoxy, 1 coat system
Coating Color:	Gray

2. DuPont

Materials obtained:	Base coat: DuPont 25P High solids epoxy mastic Top coat: Imron
Material descriptions:	25P, epoxy Imron, polyurethane enamel
Coating colors:	Base coat: Aluminum (can be used as one coat system) Top coat: Gray

3. Prax-Ten

Material obtained:	Penetrant and concentrate
Material description:	Wax-type
Coating Color:	Gray

4. Tenemec

Materials obtained:	Base coat: Series 135, Chembuild Top coat: Series 74, Endura-Shield IV, Parts A and B
Material description:	Chembuild, high-build, high-solids, catalyzed epoxy Endura-Shield, high-build acrylic polyurethane enamel
Coating color:	Gray (top coat)

5. Black Gold

Materials obtained:	Base coat: Tri-F Black Gold metal sealer Top coat: Tri-F Black Gold aluminum
Material description:	Sealer, hydrocarbon (no other information available) Aluminum, mixture of petroleum hydrocarbon, mineral spirits, xylene, and aluminum flakes
Coating color:	Aluminum (top coat)

APPENDIX C. DAILY VISUAL OBSERVATIONS DATA

Figures C1 through C10 are plots of daily visual observations on panels through the 1200 hours of tests. Individual panels are identified by the scheme explained in Table IV.

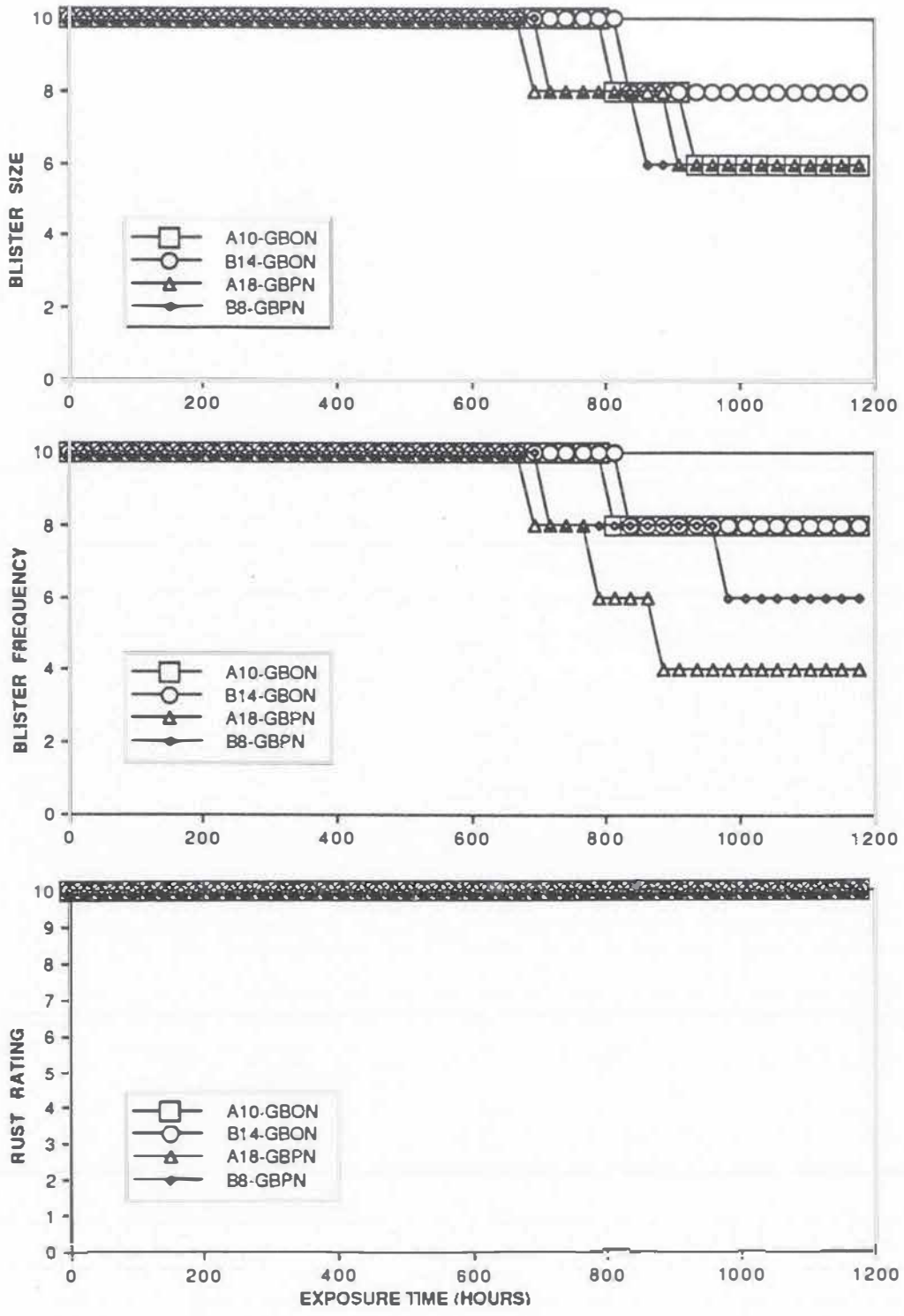

Figure C1. Daily visual observation data on Tnemec coated non-scribed panels: (a) blister size, (b) blister frequency, (c) rust rating.

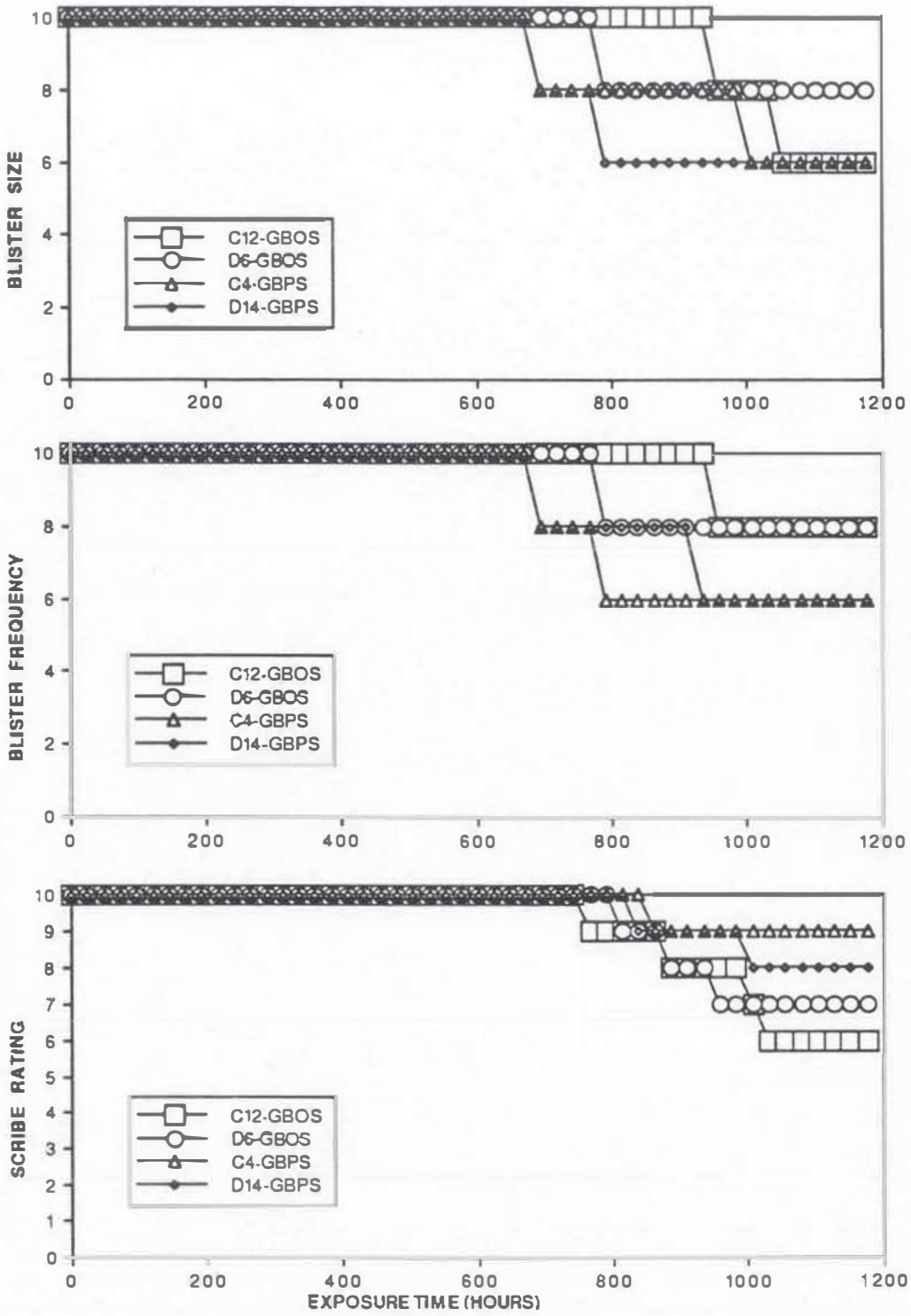

Figure C2. Daily visual observation data on Tnemec coated scribed panels: (a) blister size, (b) blister frequency, (c) scribe rating.

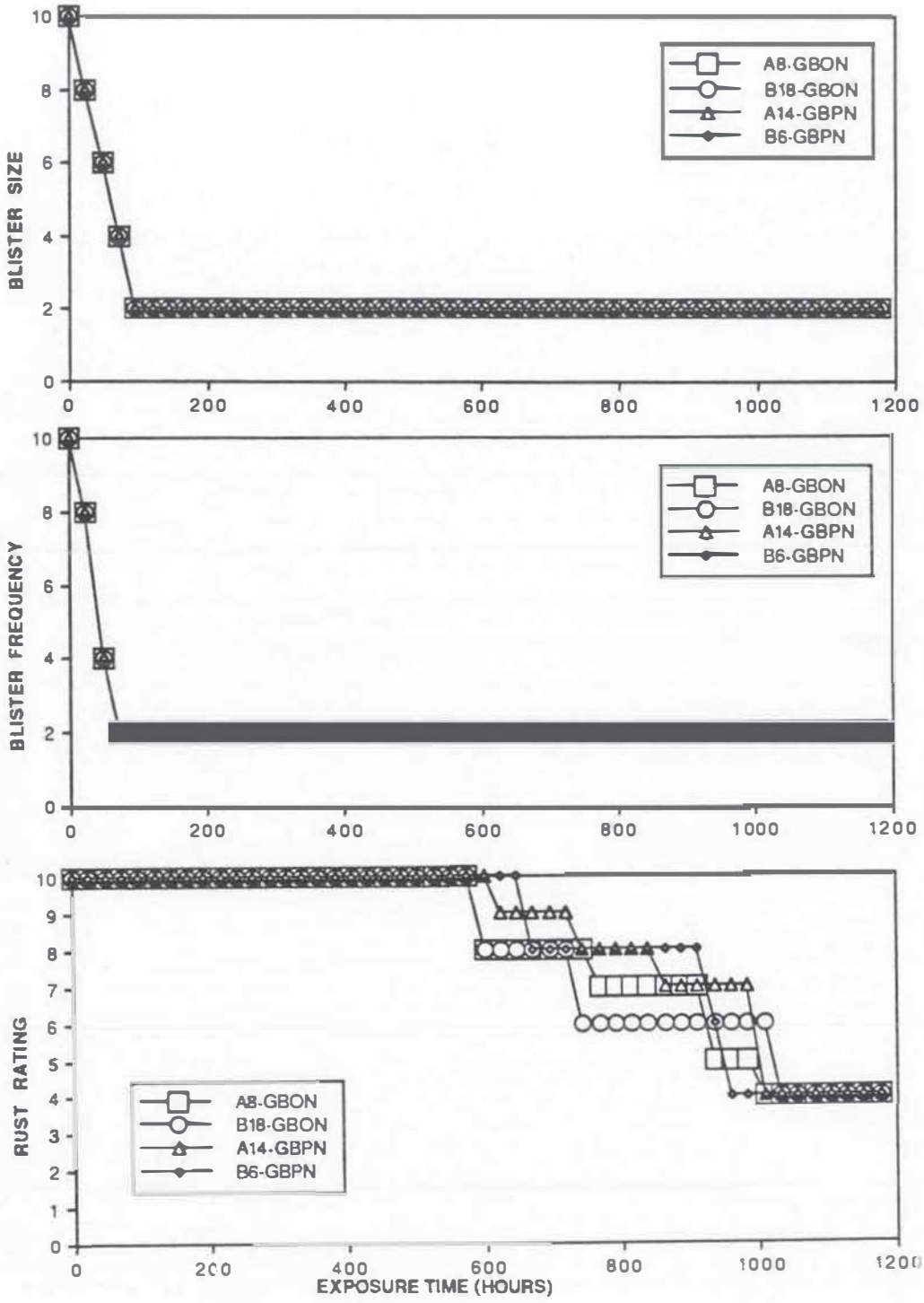

Figure C3. Daily visual observation data on Black Gold coated non-scribed panels: (a) blister size, (b) blister frequency, (c) rust rating.

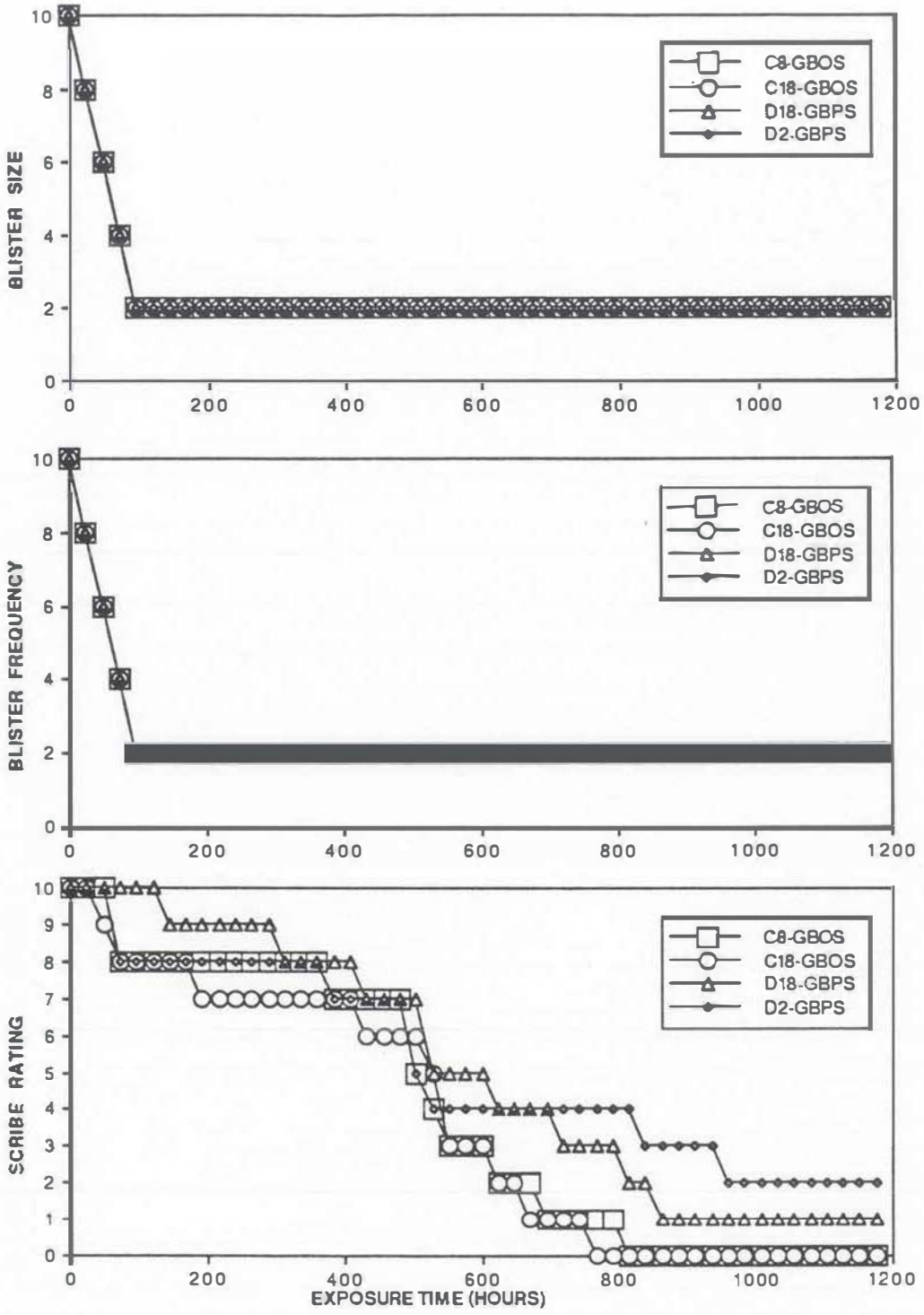

Figure C4. Daily visual observation data on Black Gold coated scribed panels: (a) blister size, (b) blister frequency, (c) scribe rating.

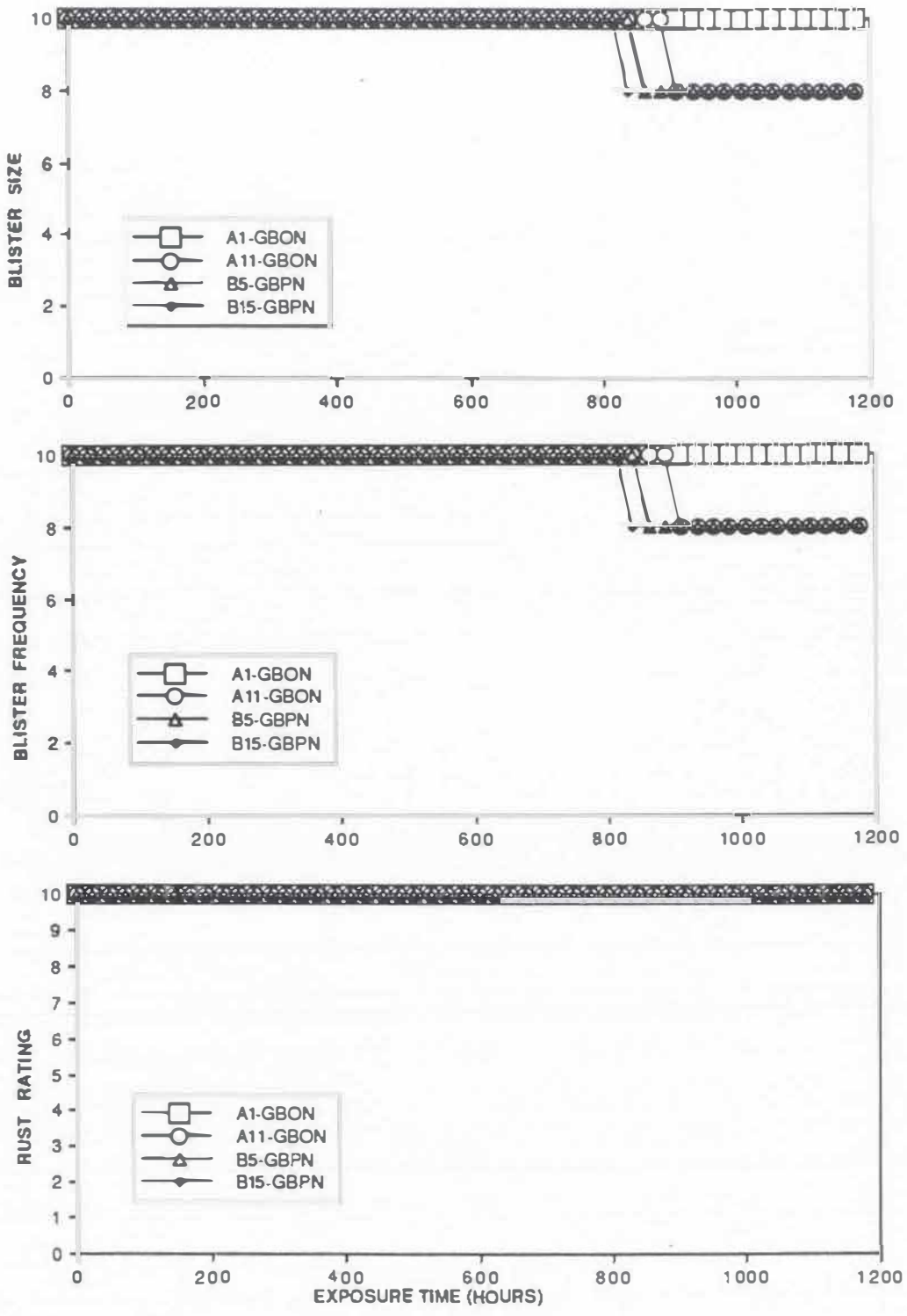

Figure C5. Daily visual observation data on DuPont coated non-scribed panels: (a) blister size, (b) blister frequency, (c) rust rating.

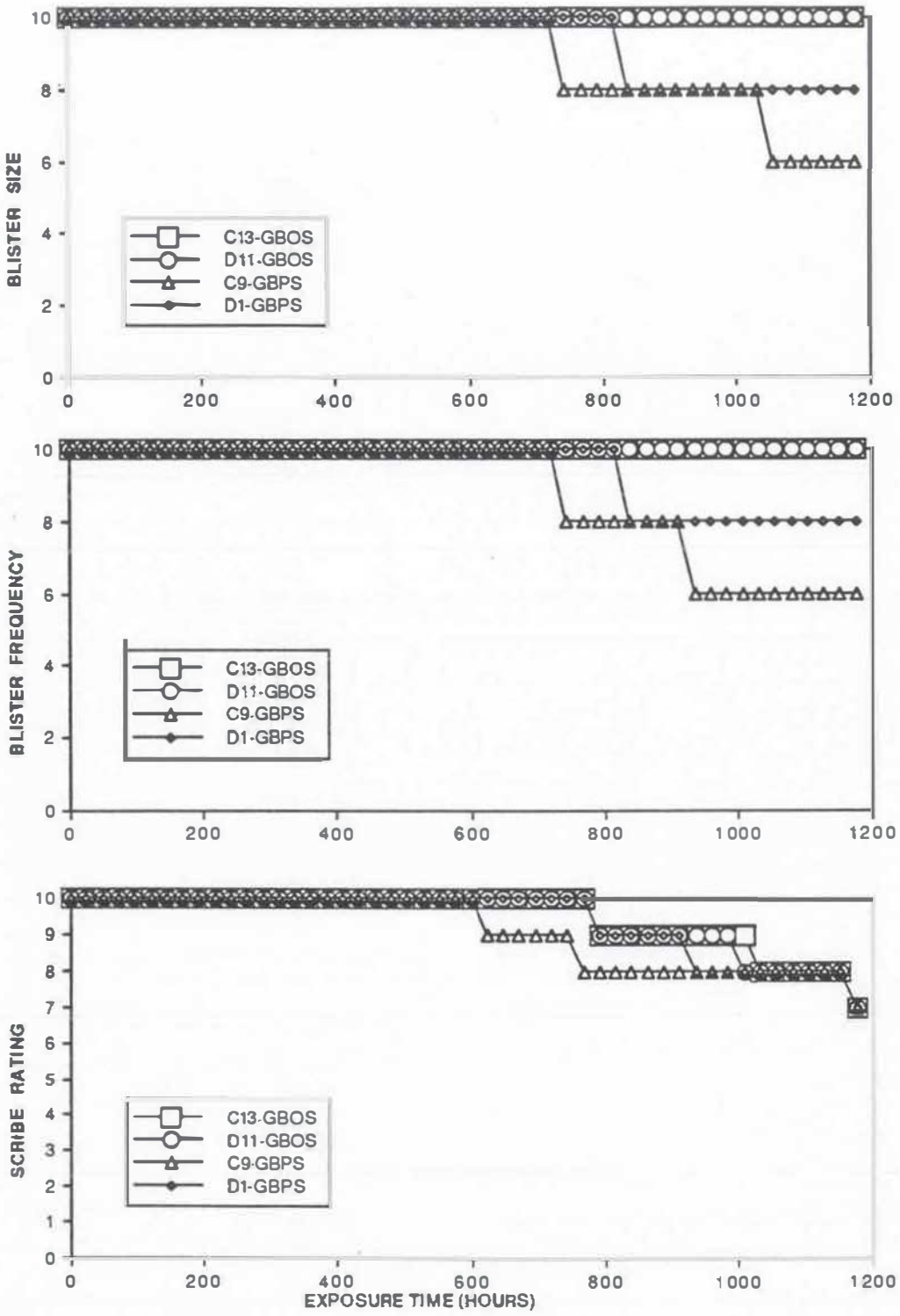

Figure C6. Daily visual observation data on DuPont coated scribed panels: (a) blister size, (b) blister frequency, (c) scribe rating.

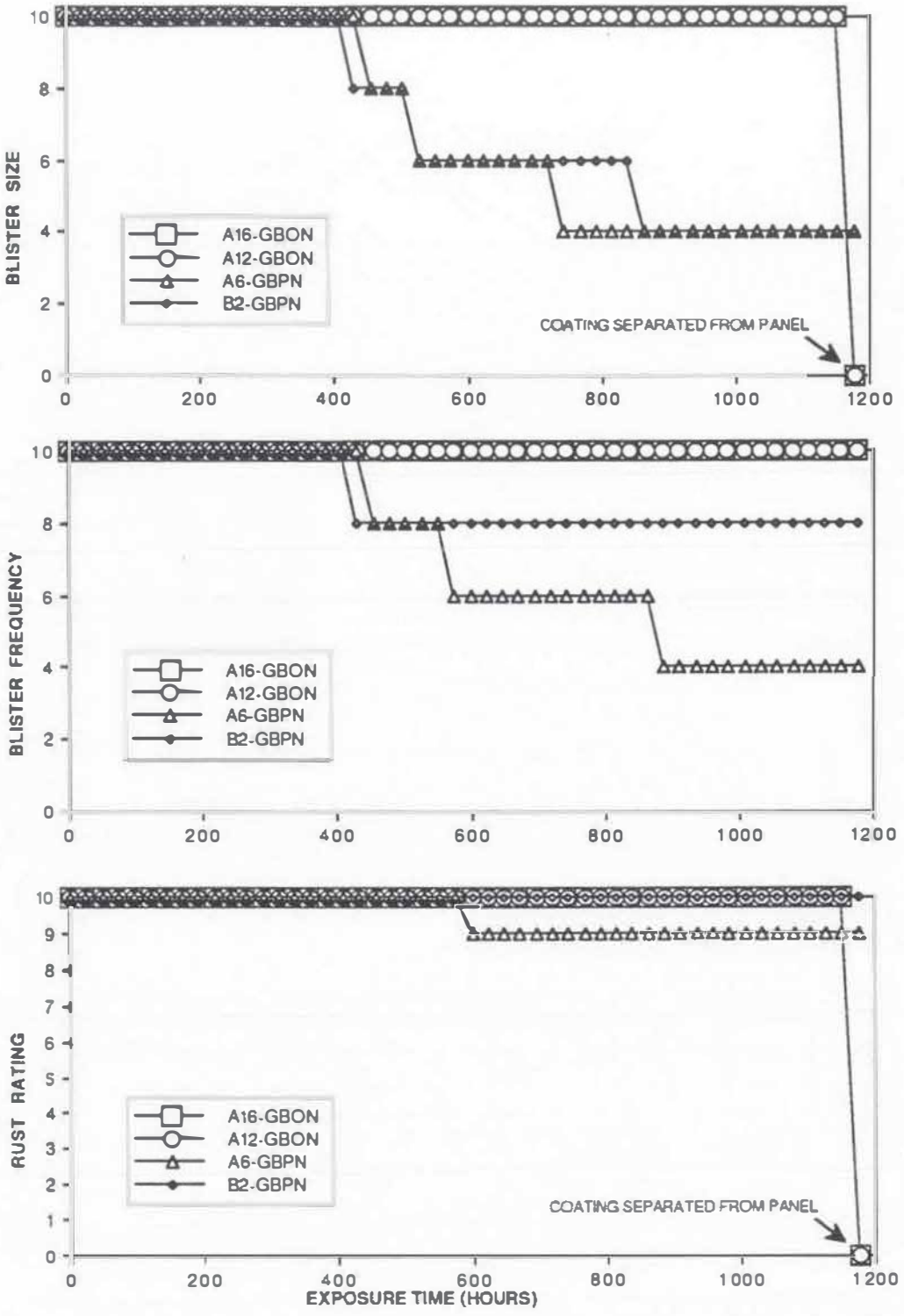

Figure C7. Daily visual observation data on Corroseal coated non-scribed panels: (a) blister size, (b) blister frequency, (c) rust rating.

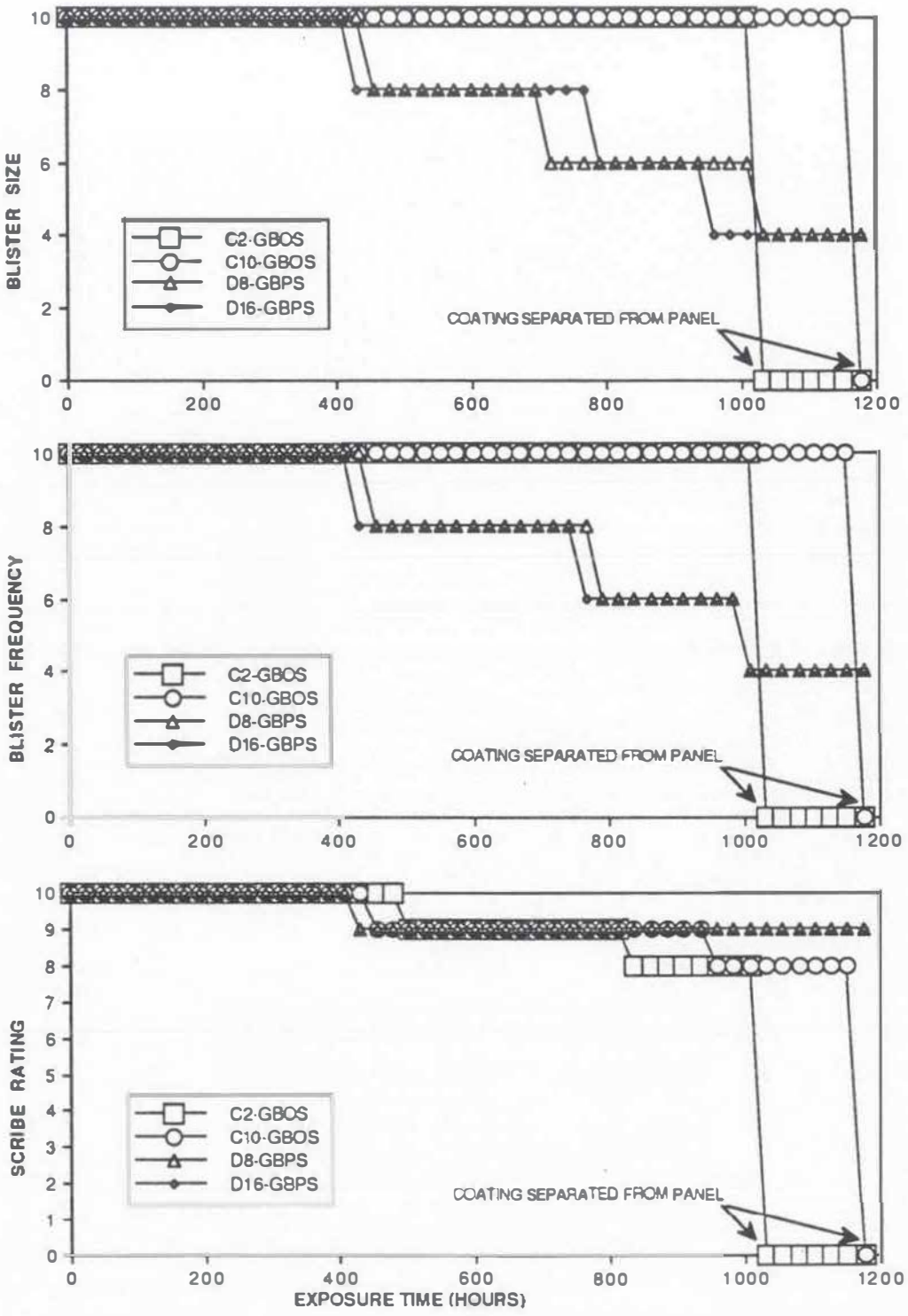

Figure C8. Daily visual observation data on Corroseal coated scribed panels: (a) blister size, (b) blister frequency, (c) scribe rating.

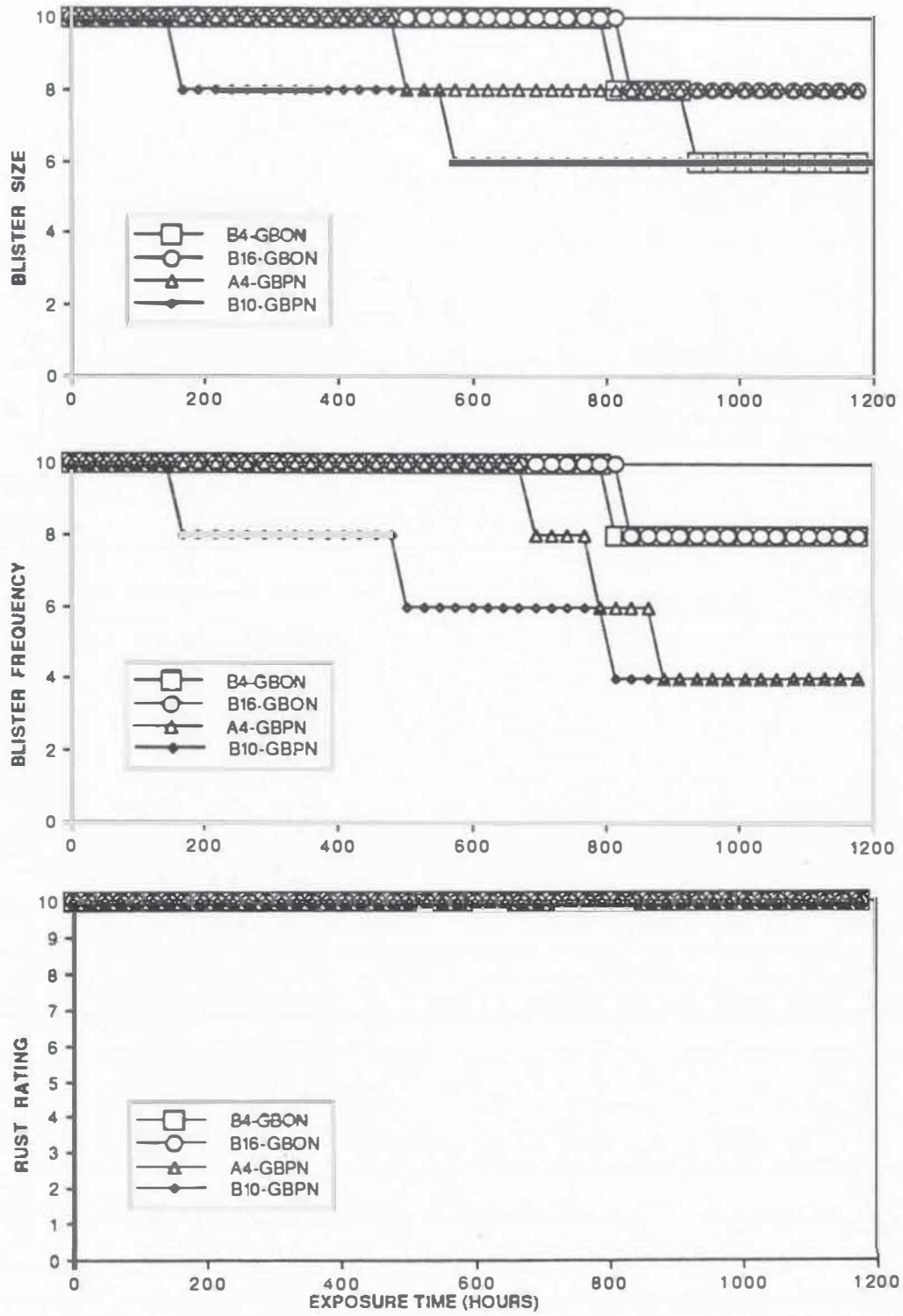

Figure C9. Daily visual observation data on Praxis coated non-scribed panels: (a) blister size, (b) blister frequency, (c) rust rating.

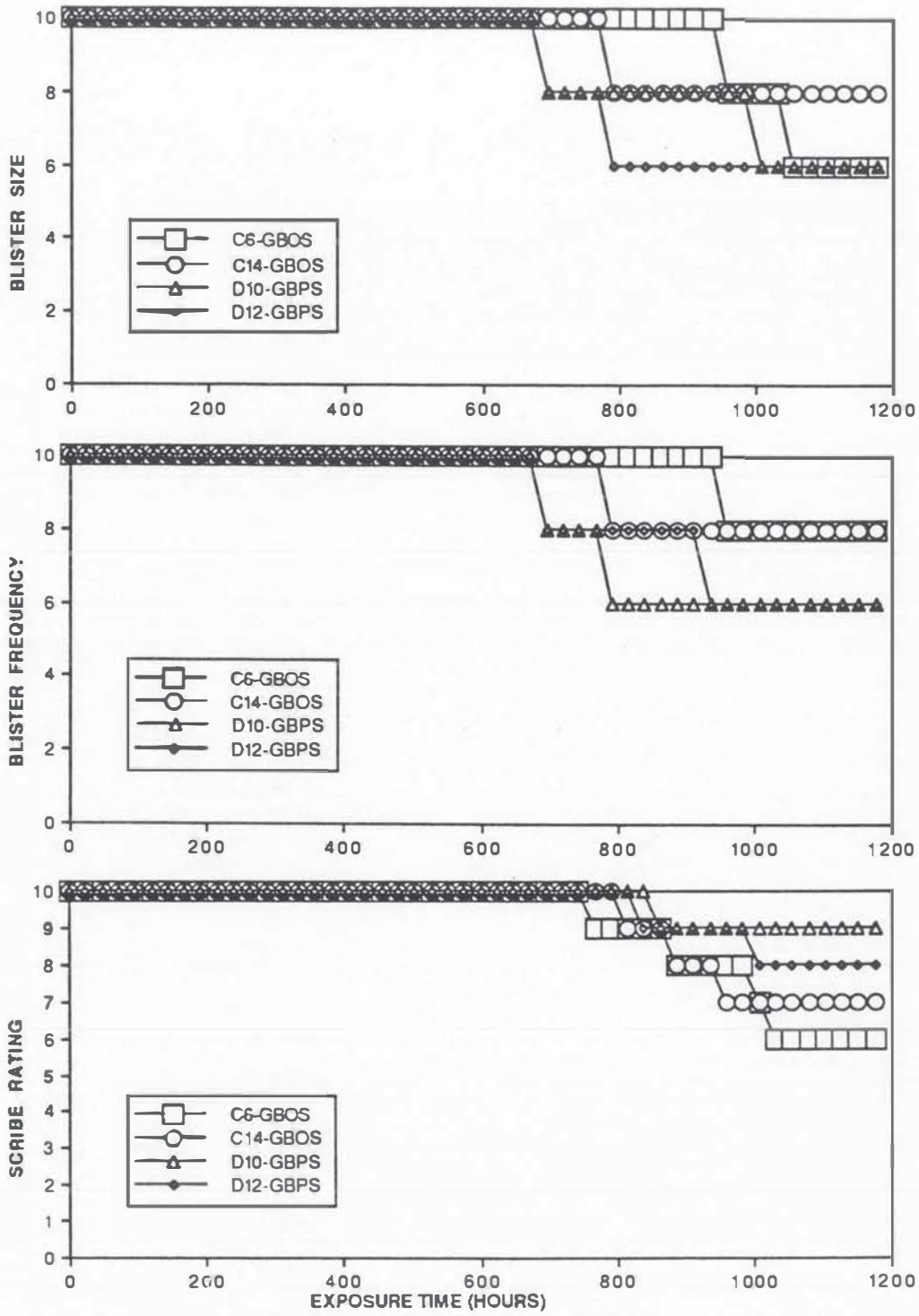

Figure C10. Daily visual observation data on Praxis coated scribed panels: (a) blister size, (b) blister frequency, (c) scribe rating.