Development of an Enhanced Durability Corrosion
Protecting Self-Priming Topcoat
Contract No. N00014-02-C-0108

R&D Status Report #18

Reporting Period: December 7, 2003 through January 6, 2004

Summary of Current Progress

- Weatherability, Filiform and SO_2 Salt Spray testing of Phase II Round 1 ladder formulations with standard inhibitors is complete
- Testing of nonchromate Phase II Round 1 ladder formulations with standard inhibitors is continuing
- Ladder samples of ESTP with hydrotalcite-based inhibitors have been prepared and delivered to Boeing St. Louis and Boeing Seattle

Phase I – Formulation Trade Studies is complete. Promising inhibitor systems have been identified for optimization in Phase II.

Phase III – Flight Test is scheduled to start in 2005.

Phase II – Optimization

Round One

Synthesis of Hydrotalcite Inhibitors

Deft has formulated ladder samples using the 13% organic inhibitor hydrotalcite inhibitor produced by Wayne Pigments. These have been delivered to St. Louis and Seattle. Panels will be prepared this month for testing. Wayne Pigments is finalizing production processes for hydrotalcite with ~20% inhibitor. This material should be available by the end of the month for formulation trials at Deft.

Performance Testing

The ladder study formulations using standard inhibitor materials continue in test. The results of tests completed to date are shown in Table 1. Data updated from last month include weathering (1500 hours exposure), neutral salt fog (2000 hr), and SO2 salt fog. All of the experimental coating systems have the APC resin system. The four inhibitor systems currently in test are the standard inhibitor package (as in the control coating), Wayne Hybricor 204, standard inhibitors with conductive pigments, and standard inhibitors with Hybricor 204. The test coatings are formulated at a PVC two levels below and two levels above the PVC used in Phase I of this program.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
12 JAN 2004	**N/A**	**07 Dec 2003 - 03 Jan 2004**

4. TITLE AND SUBTITLE
Development of an Enhanced Durability Corrosion Protecting Self-Priming Topcoat

5a. CONTRACT NUMBER
N00014-02-C-0108

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Joseph H. Osborne

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Boeing Phantom Works P.O. Box 3999 Mail Stop 84-92, Seattle, WA 98124-2499

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research Ballston Center Tower One 800 North Quincy Street Arlington, VA 22217-5660

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
Monthly report of progress in developing an enhanced self priming topcoat using high performance urethane resins and advanced concepts in nonchromate corrosion protection. The goal of the program is to develop a coating that meets and exceeds the requirements of TT-P-2756 and exceeds the performance of the existing topcoat material qualified to the specification.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**7**	

Weathering Performance Testing (Delta E)

The measurement for Delta E for coatings exposed to 1500 hours of Xenon arc are shown in Figure 1. Weathering decreases with increased inhibitor concentration. The best weathering coating is that with standard inhibitor alone with the standard inhibitor/Hybricor 204 combination a close second. The weathering or the Hybricor 204 only system shows a significant incease in Delta E as the inhitor concentration increases. Addition of conductive pigments also increase Delta E.

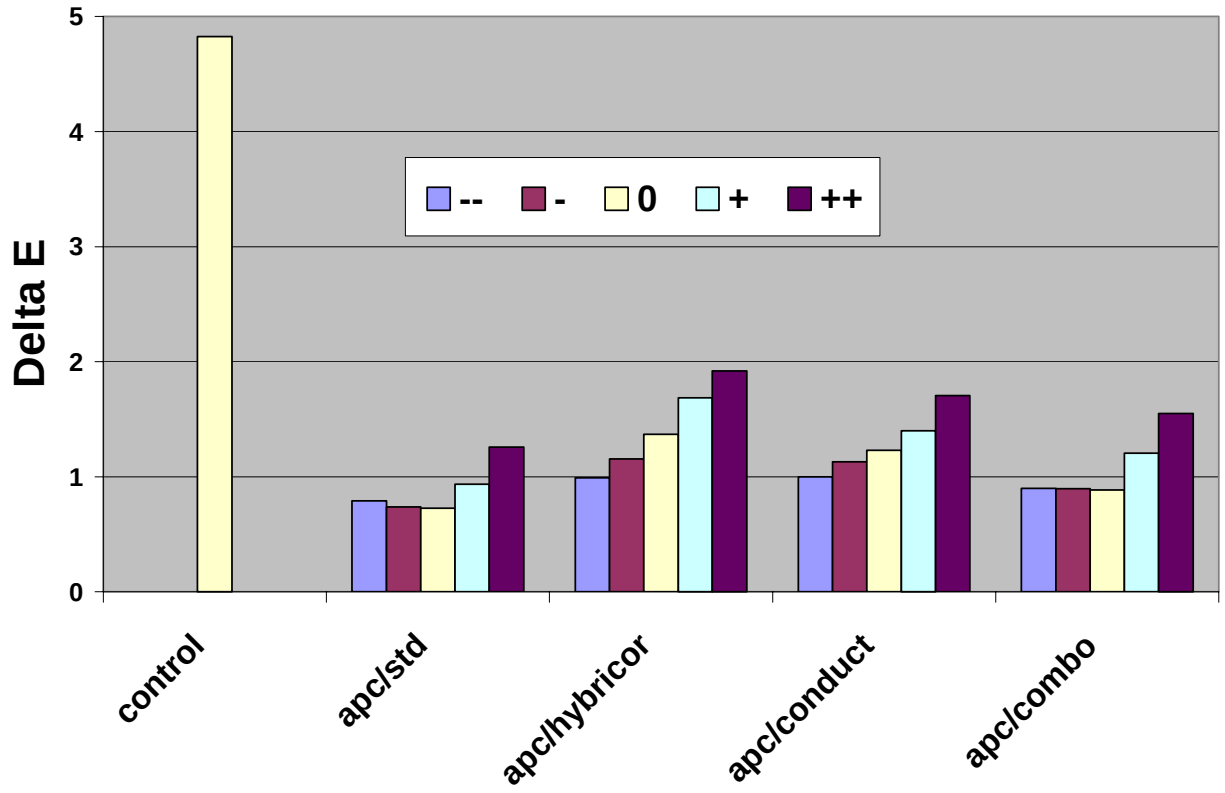

Figure 1-- Weathering Data after 1500 hours exposure to Xenon Arc

Neutral Salt Fog Performance Testing

The relative rankings of coatings exposed to neutral salt fog for 2000 hours are shown in Figure 2. All of the coatings have discoloration and small amounts of corrosion in the scribes. A few of the coatings are starting to show white corrosion in the scribe and minor blistering in the field. All of the experimental coatings are performing as well or better than the control coating. Corrosion performance increases significantly with increasing inhibitor concentration. Overall, the Hybricor 204 panels are performing best followed by the standard inhibitor package. Salt fog testing will continue to accumulate 3000 hours exposure.

These results are consistent with the RDE data that suggests increasing inhibitor concentration improves inhibition of oxygen reduction. The salt fog data do not clearly support the RDE conclusion that conductive pigments have a detrimental effect on the efficiency of inhibitors.

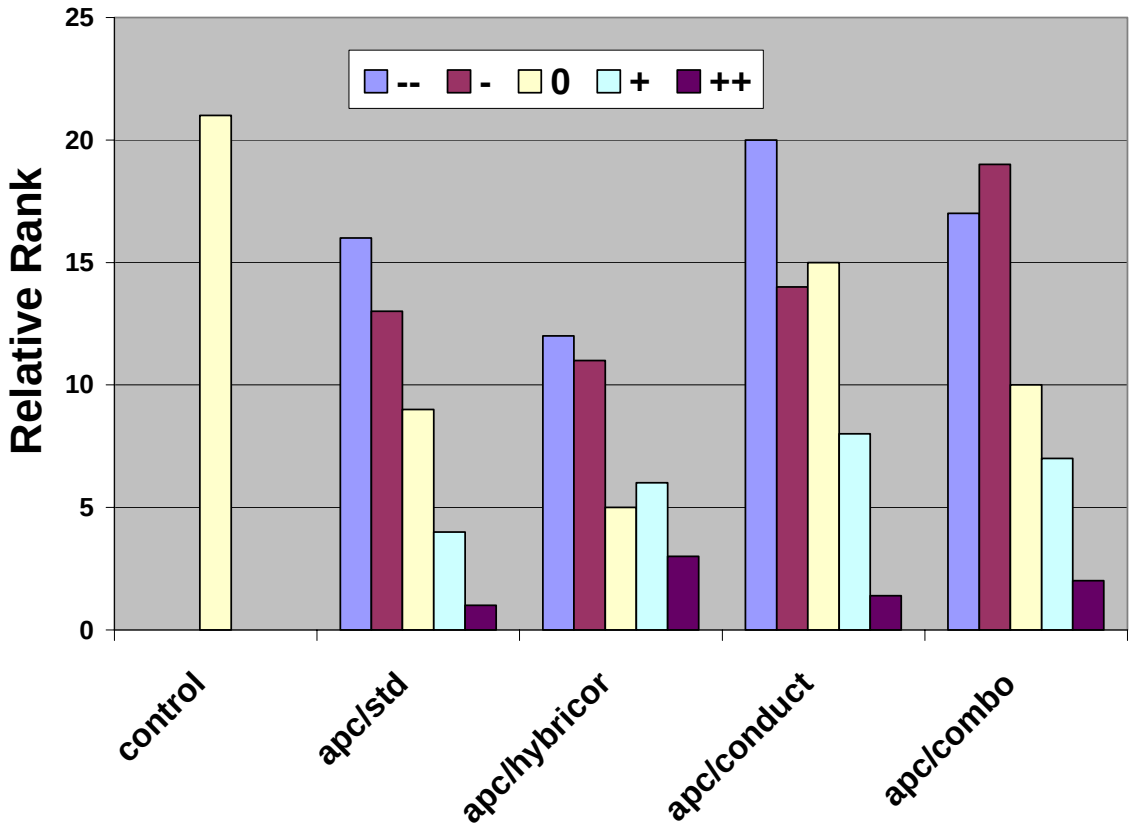

Figure 2 -- Relative Corrosion Ranking after 2000 hours Neutral Salt Fog Exposure

Filiform Corrosion Performance Testing

All coating formulations passed filiform corrosion testing. A visual ranking of the coatings shows that the 03GY369 control performed best followed in order by formulations of standard inhibitors with conductive pigments, standard inhibitors alone, Hybricor 204 formulations, and standard inhibitors with Hybricor 204.

There is very little differentiation between the coatings, however. Figure 3 shows the top ranked 03GY369 control coating on the left and the bottom ranked 97GY096 coating that has the standard inhibitor package combined with Hybricor 204. Both have approximately the same density of corrosion locations and both have one long "tail" off the bottom leg of the scribe. These panels have been lighted from the side to enhance visualization of features that extend above the base coating.

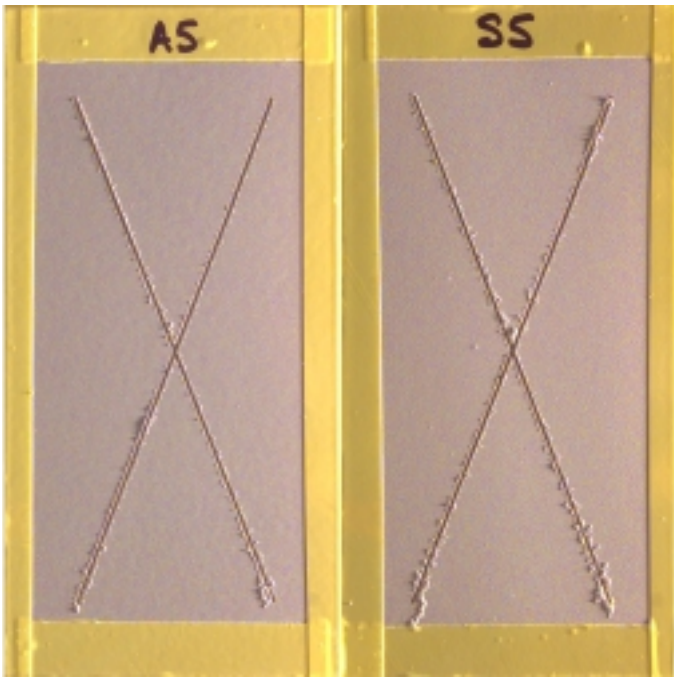

Figure 3 -- Examples of Filiform Corrosion. Left, highest ranked. Right, lowest ranked

SO_2 Salt Fog Corrosion Performance Testing

The acidified SO_2 Salt Spray testing was conducted at NAVAIR. The panels were inclined at 6° and exposed for 500 hours. Results are shown in Table 1 and Figure 4. Those coatings that contained Hybricor 204 consistently passed with high ranking. The standard inhibitor package passed at lower concentrations but not at higher concentration. Conductive pigments were detrimental to performance in this test. In general the ESPT formulations performed better than the control coating.

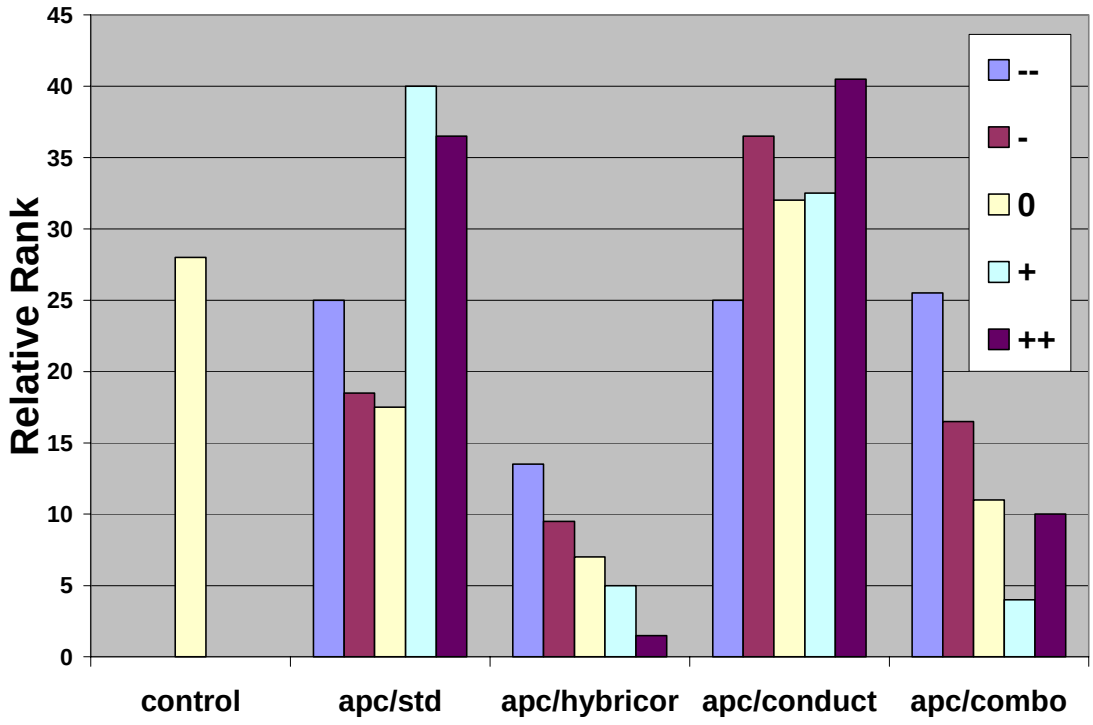

Figure 4 -- Relative Corrosion Ranking after 500 hours SO_2 Salt Fog Exposure

Nonchromate Coating Systems

The high, low, and mid inhibitor concentration formulations of the Round 1 coatings have been applied to aluminum panels with Alodine, TCP, and Boegel conversion coatings. These coating systems are in testing for neutral salt spray and filiform corrosion. Estimated completion is early March and January 2004, respectively. Cleanability and strippability testing of the formulations with medium loading levels of inhibitors will begin in January 2004.

Plans For Next Month

- Continue testing of Phase II Round 1 coatings
- Prepare test coupons with hydrotalcite formulations and begin testing.
- Evaluate adequacy and appropriateness of cleanablity test methods for modern coatings

Task Schedule: -- See Attached. Program is on schedule.

Cost Summary: -- Sent under separate cover.

Prepared by:

Joseph H. Osborne
Principal Investigator

Table 1 -- Summary of Phase II Round 1 Performance Testing

Formulation ##	Inhibitor Combination	Rel PVC	Weathering ΔE	HATE Adhesion		Wet Tape Adhesion (150F / 7 day)		RDE	Neutral Salt Fog (2000 hr)	SO_2 Salt Fog	Filiform
			1500 Hr Xenon Arc	Average	Std Dev	ASTM D3359	Rank	I/I_0	Rank	Rate/rank	Pass/fail
03GY369	TT-P-2756 coating in color 36375 (control)	**0**	4.83	2425	209	4A	13	1.2	21	Pass/28	Pass
97GY105	Standard Inhibitors	--	0.79	1950	85	5A	5	1.1	16	Pass/25	Pass
97GY111	Standard Inhibitors	-	0.74	2133	166	5A	7	1.1	13	Pass/19	Pass
99GY041E	Standard Inhibitors	**0**	0.73	2329	253	4A	9	1.1	9	Pass/18	Pass
97GY112	Standard Inhibitors	+	0.94	2390	268	4A	11	1.5	4	Fail/40	Pass
97GY102	Standard Inhibitors	++	1.26	2383	232	4A	17	1.5	1	Fail/37	Pass
97GY106	Wayncor 204	--	0.99	2108	209	5A	3	2.2	12	Pass/14	Pass
97GY113	Wayncor 204	-	1.16	1988	164	4A	11	2.1	11	Pass/10	Pass
99GY044E	Wayncor 204	**0**	1.37	1963	127	4A	14	2.7	5	Pass/7	Pass
97GY114	Wayncor 204	+	1.69	1992	106	4A	18	3.0	6	Pass/5	Pass
97GY107	Wayncor 204	++	1.92	1921	122	4A	20	3.8	3	Pass/2	Pass
97GY117	Standard Inhibitors/conductive pigments	--	1.00	2246	136	5A	1	1.2	20	Fail/25	Pass
97GY119	Standard Inhibitors/conductive pigments	-	1.13	2179	243	5A	2	1.1	14	Fail/37	Pass
97GY086	Standard Inhibitors/conductive pigments	**0**	1.23	2213	250	5A	6	1.1	15	Fail/32	Pass
97GY120	Standard Inhibitors/conductive pigments	+	1.40	2333	253	4A	16	1.0	8	Fail/33	Pass
97GY118	Standard Inhibitors/conductive pigments	++	1.71	2417	220	4A	15	1.0	1	Fail/41	Pass
97GY108	Standard Inhibitors/Wayncor 204	--	0.90	2104	128	5A	4	1.8	17	Pass/26	Pass
97GY115	Standard Inhibitors/Wayncor 204	-	0.90	2113	114	4A	10	2.0	19	Pass/17	Pass
97GY096	Standard Inhibitors/Wayncor 204	**0**	0.89	2229	145	5A	8	2.0	10	Pass/11	Pass
97GY116	Standard Inhibitors/Wayncor 204	+	1.21	2171	164	4A	19	2.4	7	Pass/4	Pass
97GY109	Standard Inhibitors/Wayncor 204	++	1.55	2150	102	4A	21	2.4	2	Pass/10	Pass

Program Schedule – June 2002 through May 2005