TESTING DEPARTMENT ABSTRACT REPORT

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TESTING PROJECT: 02840 **DATE:** June 2, 1992

REPORT #: One **TIME:** 11 1/2 Days **DATE OF GRADING:** 4/10/92; 4/24/92

TOTAL DESIGN TEST DURATION: 11 1/2 Days **REQUESTED BY:** Jerry Arnold

TITLE: Monticello Torus Phenoline 368 WG DBA Testing Over Residual Coatings

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REFERENCE: Mr. Scott McCall, Northern States Power Company (Monticello); Testing Report #02716

PURPOSE: The surface preparation procedures used at Monticello left residual zinc (Carbo Zinc 11 SG) or epoxy primer (Phenoline 368 Primer) on the surface in some areas. One objective of this test program is to evaluate maintenance coating performance over residual, "existing" coatings.

SYSTEMS:

I. Original (Prepared by Carboline Company):

1. 1c Carbo Zinc 11 SG/1c Phenoline 368 WG;
2. 1c Phenoline 368 Primer/1c Phenoline 368 WG.

Steel panels were first blasted and coated with the original systems. These systems were then partially removed by waterblasting (at Monticello) and then submitted to Carboline for application of the replacement systems, Phenoline 368 WG.

II. Residual Systems:

1. Panels were received from Monticello and they were sweepblasted to eliminate the slight flash rust.
2. Panels originally coated with 1c Carbo Zinc 11 SG/1c Phenoline 368 WG were sweepblasted and scraped with a hand tool to bare steel or to leave residual coatings:
   a) Carbo Zinc 11 SG/Phenoline 368 WG
   b) Carbo Zinc 11 SG
3. Panels originally coated with 1c Phenoline 368 Primer/1c Phenoline 368 WG were sweepblasted to bare steel or leaving residual coating Phenoline 368 Primer.

III. Repair Systems:

1c, 2c, 3c or 4 coats of Phenoline 368 WG.

EXPOSURE: Irradiation to 3 x 10^8 rads at Sterigenics International, followed by 281°F LOCA.

Evaluation of test specimens in the vapor phase and immersion phase of the auto clave simulated coating exposure in the torus above and below the waterline.

281°F LOCA Curve:

(a) Time - Temperature - Pressure Curve

Time*	Temperature*	Pressure*
Initial to 1 sec.	175°F to 281°F	8 psig to 42 psig
100 sec.	281°F	27 psig
600 sec.	190°F	8 psig
21 min.	260°F	33 psig
1 hour, 23 min.	225°F	17 psig
4 hours	225°F	17 psig
11.5 days	115°F	2.5 psig

* These are theoretical values. The data for the actual LOCA curves are taken from the chart recording for this test found on pages 162 and 163, Lab Book 370.

(b) Water Chemistry
Deionized water

LOCA Grading Procedure
(ANSI N101.2-1972)
Grading within two hours and after 14 days following removal from the test chamber. There was no difference between two hour and two week gradings. Also, there was no difference between vapor and liquid exposures.

CONCLUSIONS: See Summary of Results.

Carl L. Braun
Carl Braun
Advanced Laboratory Technician
Testing Department

Yuly Korobov
Yuly Korobov
Supervisor
Testing Department

S.L. Steinberg/M.D. Teller/J.F.Montle/P.S. Litzsinger/D. Meyer/J.N. Webster/L.S. Salem/
S.J. Harrison/Group Leaders

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281°F LOCA

COATING SYSTEM	DRY FILM THICKNESS RANGE, MILS	FLAKING	DELAMINATION OR PEELING	BLISTERING	CRACKING	CHALKING
1c Carbo Zinc 11 SG/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline to Bare Steel/ 3c Phenoline 368 WG (Side A) 4c Phenoline 368 WG (Side B)[1]	2.2 - 3.1 8.8 - 11.9 24.8 - 28.4 30.0 - 33.4	None	None	None	None	None
1c Carbo Zinc 11 SG/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline Leaving Residual Coating[3]/ 3c Phenoline 368 WG (Side A) 4c Phenoline 368 WG (Side B)[2]	2.5 - 3.0 8.8 - 9.8 9.4 - 10.3 23.1 - 23.7 29.0 - 29.7	None	None	None	None	None
1c Carbo Zinc 11 SG/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline Leaving Residual Coating[3]/ 3c Phenoline 368 WG (Side A) 4c Phenoline 368 WG (Side B)[2]	2.3 - 3.1 10.4 - 11.5 2.7 - 3.5 25.1 - 25.2 31.4 - 32.2	None	None	None	None	None
1c Carbo Zinc 11 SG/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline Leaving Residual Coating[4]/ 3c Phenoline 368 WG (Side A) 4c Phenoline 368 WG (Side B)[2]	2.2 - 3.1 11.4 - 11.9 2.0 - 2.9 24.9 - 26.1 31.3 - 32.4	None	None	None	None	None

anels exhibited coating discoloration.
Results are from 12 panel sides.
Results are from 4 panel sides.
Residual Coating: 1c Carbo Zinc 11 SG/1c Phenoline 368 WG
Residual Coating: 1c Carbo Zinc 11 SG

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281°F LOCA

COATING SYSTEM	DRY FILM THICKNESS RANGE, MILS	FLAKING	DELAMINATION OR PEELING	BLISTERING	CRACKING	CHALKING
1c Phenoline 368 Primer/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline to Bare Steel/ 2c Phenoline 368 WG (Side A) 3c Phenoline 368 WG (Side B)[1]	3.8 - 4.6 7.1 - 8.2 13.5 - 14.4 23.9 - 26.5	None	None	None	None	None
1c Phenoline 368 Primer/ 1c Phenoline 368 WG Waterblasted at Monticello; Sweepblasted at Carboline Leaving Residual Coating[3]/ 2c Phenoline 368 WG (Side A) 3c Phenoline 368 WG (Side B)[1]	3.8 - 4.6 7.1 - 8.2 2.0 - 2.5 13.6 - 14.8 23.7 - 26.4	None	None	None	None	None

nels exhibited coating discoloration.

Results are from 8 panel sides.
Residual Coating: 1c Phenoline 368 Primer

LABORATORY TEST REPORT

TESTING PROJECT: 02840 **DATE:** June 2, 1992

REPORT #: One **TIME:** 11 1/2 Days **DATE OF GRADING:** 4/10/92; 4/24/92

TOTAL DESIGN TEST DURATION: 11 1/2 Days **REQUESTED BY:** Jerry Arnold

TITLE: Monticello Torus Phenoline 368 WG DBA Testing Over Residual Coatings

---

PURPOSE: The surface preparation procedures used at Monticello left residual zinc (Carbo Zinc 11 SG) or epoxy primer (Phenoline 368 Primer) on the surface in some areas. One objective of this test program is to evaluate maintenance coating performance over residual, "existing" coatings.

CONCLUSIONS: See Summary of Results.

PROCEDURE:

A. Test Coupons

Description: 2" x 4" x 1/4" steel panels certified Carboline ST1 (See Appendix 1).

Surface Preparation:

Panels stamped 1, 2, 6, 8, 9 and 10 were coated at Carboline with 1c Carbo Zinc 11 SG/1c Phenoline 368 WG.

Panels stamped 17, 20, 21 and 22 were coated at Carboline with 1c Phenoline 368 Primer/1c Phenoline 368 WG.

All panels were shipped to Monticello Nuclear Generating Plant, where they were waterblasted to partially remove coatings.

Panels were then shipped back to Carboline and they were sweepblasted because slight flash rusting had occurred.

Carbo Zinc 11 SG/Phenoline 368 WG panels were sweepblasted and scraped with a hand tool to bare steel or leaving residual coating.

Phenoline 368 Primer/Phenoline 368 WG panels were sweepblasted to bare steel or leaving residual coating.

Abrasive Medium: (On steel panels blasted at Carboline)
50/50 mix of GFH #40 grit and S230 shot.

B. Systems Tested

Coating	Batch Number Part A	Part B	Color	Thinner	Dry Film Thickness Range (Mils)
I.					
1c Carbo Zinc 11 SG/	1G9394M	1A7334Z	Green 0700	TH#26 (18%) 0B9365M	2.2 - 3.1
1c, 2c, 3c, 4c, 5c					
Phenoline 368 WG	1B9043M	1F9362M	Green 0773	Phenoline (18%) 1F9355M	5.4-12.9/Coat
II.					
1c Phenoline 368 Primer/	9H9007M	9H9008M	White 0800	Phenoline (18%) 1F9355M	3.8 - 4.6
1c, 2c, 3c, 4c					
Phenoline 368 WG	1B9043M	1F9362M	Green 0773	Phenoline (18%) 1F9355M	4.3-11.1/Coat

[1] For actual coating DFTS refer to result pages.

SYSTEM SUMMARY AND TOTAL DRY FILM THICKNESS

Each side of coated panels after repair procedure had various areas with residual coatings and bare steel. To determine the dry film thickness of residual coatings, a mapping technique was used. Each panel side was xeroxed after repair, and then dry film thicknesses were measured over the same spot after each coating was applied. (See attached page with example of mapping).

SYSTEM SUMMARY (TOTAL DFT, MILS)

Panel No.	Side	Original System		System After Repair (Residual)			Topcoat (Phenoline 368 WG)			
		1c Carbo Zinc 11 SG	1c Phenoline 368 WG	Bare Steel	Carbo Zinc 11 SG	Carbo Zinc 11 SG/ Phenoline 368 WG	1 Coat	2 Coats	3 Coats	4 Coats
1A	A	2.8	9.8			10.3	15.7	27.2	33.4	
		2.8	9.8	0	-	-	7.3	17.4	24.8	
	B	2.5	9.7			10.1	16.3	25.4	32.5	39.0
		2.5	9.7	0	-	-	7.0	16.0	23.6	30.1
2A	A	3.0	8.8			9.7	16.6	25.2	33.4	
		3.0	8.8	0	-	-	6.8	17.3	25.0	
	B	2.8	9.4			9.4	15.7	25.2	32.5	39.1
		2.8	9.4	0	-	-	6.9	16.2	22.7	30.6
6A	A	2.6	10.4			3.4	10.3	19.5	28.5	
		2.6	10.4	0	-	-	8.9	17.4	26.0	
	B	2.3	11.4			2.7	11.7	19.5	27.0	34.1
		2.3	11.4	0	-	-	9.5	18.0	25.9	32.5
8A	A	2.2	11.5		2.0		10.7	20.1	27.2	
		2.2	11.5	0	-	-	9.5	19.9	27.3	
	B	2.3	11.5		2.3		11.0	21.1	27.0	34.5
		2.3	11.5	0	-	-	8.7	19.8	25.4	33.4

SYSTEM SUMMARY (TOTAL DFT, MILS)

anel o:	Side	Original System		System After Repair (Residual)			Topcoat (Phenoline 368 WG)			
		1c Carbo Zinc 11 SG	1c Phenoline 368 WG	Bare Steel	Carbo Zinc 11 SG	Carbo Zinc 11 SG/ Phenoline 368 WG	1 Coat	2 Coats	3 Coats	4 Coats
9A	A	3.1	11.4		2.9		11.6	20.9	27.8	
		3.1	11.4	0	-	-	8.8	19.1	26.8	
	B	3.0	11.9			3.5	11.5	21.1	28.0	34.8
		3.0	11.9	0	-	-	8.2	18.2	24.5	32.0
10A	A	3.1	11.8			3.4	11.1	21.8	29.5	
		3.1	11.8	0	-	-	8.5	21.4	28.4	
	B	2.9	11.6			3.5	12.1	21.6	28.4	35.9
		2.9	11.6	0	-	-	8.4	19.4	26.0	33.1

SYSTEM SUMMARY (TOTAL DFT, MILS)

anel lo.	Side	Original System		System After Repair (Residual)			Topcoat (Phenoline 368 WG)			
		1c Phenoline 368 Primer	1c Phenoline 368 WG	Bare Steel		Phenoline 368 Primer	1 Coat	2 Coats	3 Coats	
17A	A	3.8	7.8			2.5	8.9	16.1		
		3.8	7.8	0		-	6.7	13.6		
	B	4.6	7.2			2.4	10.3	19.2	26.1	
		4.6	7.2	0		-	7.8	17.3	25.0	
20A	A	3.8	8.0			2.5	8.8	16.6		
		3.8	8.0	0		-	6.15	14.35		
	B	3.8	7.1			2.2	11.0	21.7	28.6	
		3.8	7.1	0		-	8.5	19.6	23.9	
21A	A	4.0	7.7				9.6	16.8		
		4.0	7.7	0		-	6.9	13.5		
	B	4.3	7.7				9.3	17.1	24.7	
		4.3	7.7	0		-	7.9	17.5	25.5	
22A	A	3.8	8.2			2.2	8.3	17.0		
		3.8	8.2	0		-	6.2	14.4		
	B	3.8	7.2			2.3	11.7	20.6	28.4	
		3.8	7.2	0		-	9.2	19.4	26.5	

C. Cure Schedule

Coating	Panel Side	Cure
Carbo Zinc 11 SG	A[1], B[1]	3 Days @ 100°F; 100% RH
Phenoline 368 Primer	A[1], B[1]	3 Days @ Ambient Conditions
Phenoline 368 WG	A[1], B[1]	2 Weeks @ 150°F 4 Months Ambient Conditions
Phenoline 368 WG (Applied over Zinc Primer)	A[2], B[2]	2 Days Ambient Conditions
	A[3], B[3]	3 Days @ 150°F
	A[4], B[4]	3 Days @ 150°F
	A[4*], B[5*]	31 Days Ambient Conditions **
Phenoline 368 WG (Applied over Phenoline 368 Primer)	A[2], B[2]	2 Days Ambient Conditions
	A[3], B[3]	3 Days Ambient Conditions
	A[3*], B[4*]	35 Days Ambient Conditions **

[1] 1st Coat
[2] 2nd Coat
[3] 3rd Coat
[4] 4th Coat
[5] 5th Coat
* Final Cure
** Before and after irradiation

EXPOSURE: Irradiation to 3×10^6 rads at Sterigenics International, followed by 281°F LOCA.

Evaluation of test specimens in the vapor phase and immersion phase of the auto clave simulated coating exposure in the torus above and below the waterline.

281°F LOCA Curve:

(a) Time - Temperature - Pressure Curve

Time*	Temperature*	Pressure*
Initial to 1 sec.	175°F to 281°F	8 psig to 42 psig
100 sec.	281°F	27 psig
600 sec.	190°F	8 psig
21 min.	260°F	33 psig
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11.5 days	115°F	2.5 psig

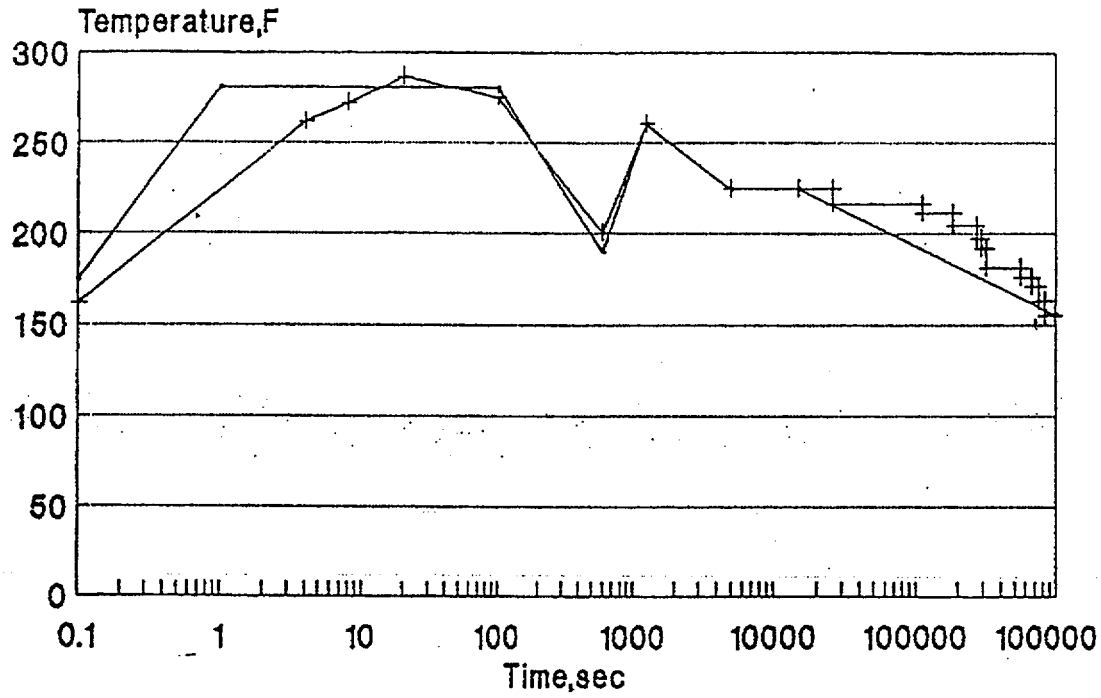
* These are theoretical values. The data for the actual LOCA curves are taken from the chart recording for this test found on pages 162 and 163, Lab Book 370.

(b) Water Chemistry
Deionized water

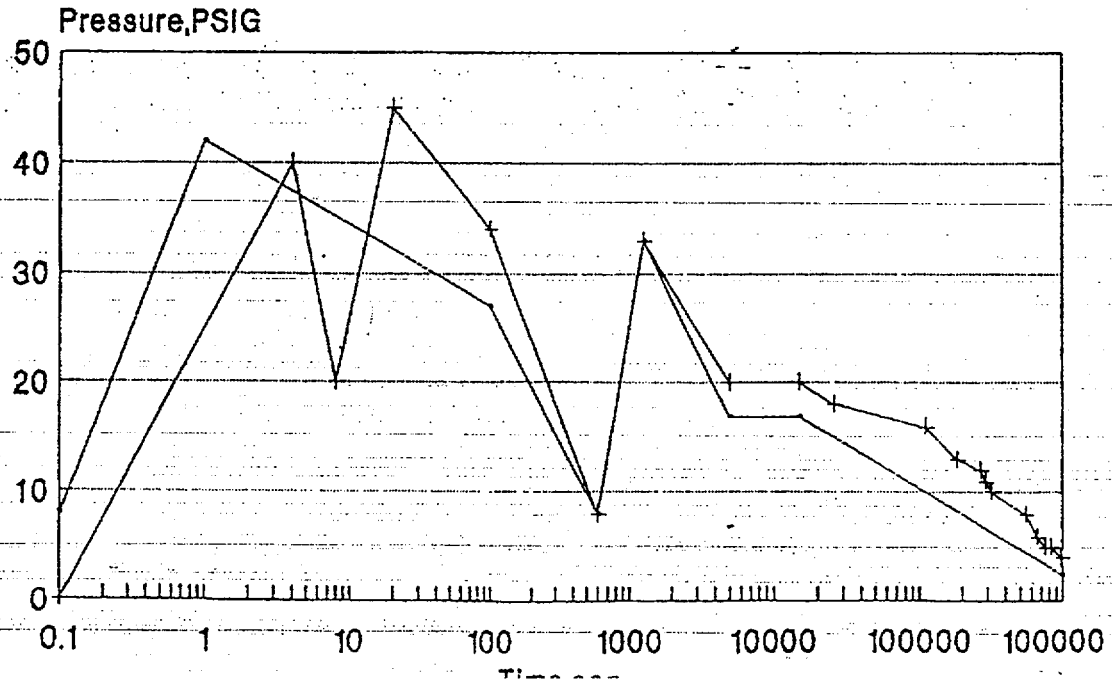
LOCA Grading Procedure
(ANSI N101.2-1972)
Grading within two hours and after 14 days following removal from the test chamber. There was no difference between two hour and two week gradings. Also, there was no difference between vapor and immersion exposures.

Monticello LOCA

Temperature Curve



Pressure Curve



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281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	A	2.8 9.8 7.3/10.1/7.4	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline ing Residual Coating[1]/ Phenoline 368 WG	A	2.8 9.8 10.3 5.4/11.5/6.2	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	B	2.5 9.7 7.0/9.0/7.6/6.4	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline ing Residual Coating[1]/ Phenoline 368 WG	B	2.5 9.7 10.1 6.2/9.1/7.1/6.6	None	None	None	None	None

exhibited coating discoloration
rbo Zinc 11 SG/Phenoline 368 WG

* Panel suspended in liquid phase.

281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	A	3.0 8.8 6.8/10.5/7.7	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline ng Residual Coating[1]/ henoline 368 WG	A	3.0 8.8 9.7 6.9/8.6/8.2	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	B	2.8 9.4 6.9/9.3/6.5/7.9	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline ng Residual Coating[1]/ henoline 368 WG	B	2.8 9.4 9.4 6.3/9.5/7.3/6.6	None	None	None	None	None

exhibited coating discoloration
o Zinc 11 SG/Phenoline 368 WG

* Panel suspended in vapor phase.

281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
:arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	A	2.6 10.4 8.9/8.5/8.6	None	None	None	None	None
:arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted and Scraped at Carboline ing Residual Coating[1]/ henoline 368 WG	A	2.6 10.4 3.4 6.9/9.2/9.0	None	None	None	None	None
:arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	B	2.3 11.4 9.5/8.5/7.9/6.6	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted and Scraped at Carboline ing Residual Coating[1]/ henoline 368 WG	B	2.3 11.4 2.7 9.0/7.8/7.5/7.1	None	None	None	None	None

exhibited coating discoloration
oo Zinc 11 SG/Phenoline 368 WG

* Panel suspended in liquid phase.

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Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	A	2.2 11.5 9.5/10.4/7.4	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted and Scraped at Carboline ng Residual Coating[1]/ henoline 368 WG	A	2.2 11.5 2.0 8.7/9.4/7.1	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	B	2.3 11.5 8.7/11.1/5.6/8.0	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; pblasted and Scraped at Carboline ng Residual Coating[1]/ henoline 368 WG	B	2.3 11.5 2.3 8.7/10.1/5.9/7.5	None	None	None	None	None

exhibited coating discoloration
oo Zinc 11 SG

* Panel suspended in vapor phase.

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281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	A	3.1 11.4 8.8/10.3/7.7	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted and Scraped at Carboline ving Residual Coating[1]/ Phenoline 368 WG	A	3.1 11.4 2.9 8.7/9.3/6.9 24.9	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	B	3.0 11.9 8.2/10.0/6.3/7.5	None	None	None	None	None
Carbo Zinc 11 SG/ Phenoline 368 WG erblasted at Monticello; epblasted and Scraped at Carboline ving Residual Coating[1]/ Phenoline 368 WG	B	3.0 11.9 3.5 8.0/9.6/6.9/6.8 31.3	None	None	None	None	None

exhibited coating discoloration
bo Zinc 11 SG
bo Zinc 11 SG/Phenoline 368 WG

* Panel suspended in vapor phase.

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281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	A	3.1 11.8 8.5/12.9/7.0	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted and Scraped at Carboline ing Residual Coating[1]/ henoline 368 WG	A	3.1 11.8 3.4 7.7/10.7/7.7	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	B	2.9 11.6 8.4/11.0/6.6/7.1	None	None	None	None	None
arbo Zinc 11 SG/ henoline 368 WG rblasted at Monticello; epblasted and Scraped at Carboline ing Residual Coating[1]/ henoline 368 WG	B	2.9 11.6 3.5 8.6/9.5/6.8/7.5	None	None	None	None	None

exhibited coating discoloration
bo Zinc 11 SG/Phenoline 368 WG

* Panel suspended in liquid phase.

281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	A	3.8 7.8 6.7/6.9	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; pblasted at Carboline ng Residual Coating[1]/ henoline 368 WG	A	3.8 7.8 2.5 6.4/7.2	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; pblasted at Carboline to Bare Steel/ henoline 368 WG	B	4.6 7.2 7.8/9.5/7.7	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; pblasted at Carboline ng Residual Coating[1]/ henoline 368 WG	B	4.6 7.2 2.4 7.9/8.9/6.9	None	None	None	None	None

exhibited coating discoloration
noline 368 Primer

* Panel suspended in liquid phase.

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281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	A	3.8 8.0 6.15/8.2	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; epblasted at Carboline ing Residual Coating[1]/ henoline 368 WG	A	3.8 8.0 2.5 6.3/7.8	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; epblasted at Carboline to Bare Steel/ henoline 368 WG	B	3.8 7.1 8.5/11.1/4.3	None	None	None	None	None
henoline 368 Primer/ henoline 368 WG rblasted at Monticello; epblasted at Carboline ing Residual Coating[1]/ henoline 368 WG	B	3.8 7.1 2.2 8.8/10.7/6.9	None	None	None	None	None

exhibited coating discoloration
noline 368 Primer

* Panel suspended in liquid phase.

281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	A	4.0 7.7 6.9/6.6	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline ving Residual Coating[1]/ Phenoline 368 WG	A	4.0 7.7 2.3 7.3/7.2	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	B	4.3 7.7 7.9/9.6/8.0	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline ving Residual Coating[1]/ Phenoline 368 WG	B	4.3 7.7 2.0 7.3/7.8/7.6	None	None	None	None	None

exhibited coating discoloration
enoline 368 Primer

* Panel suspended in vapor phase.

Testing Project: 02840
Report: One, 11 1/2 Days
Results:

Grading Date: 4/10/92; 4/24/92

281°F LOCA*

Panel Identification and Coating System	Panel Side	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Cracking	Chalking
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline to Bare Steel/ Phenoline 368 WG	A	3.8 8.2 6.2/8.2	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG erblasted at Monticello; epblasted at Carboline ving Residual Coating[1]/ Phenoline 368 WG	A	3.8 8.2 2.2 6.1/8.7	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG terblasted at Monticello; eepblasted at Carboline to Bare Steel/ Phenoline 368 WG	B	3.8 7.2 9.2/10.2/7.1	None	None	None	None	None
Phenoline 368 Primer/ Phenoline 368 WG terblasted at Monticello; eepblasted at Carboline ivir g Residual Coating[1]/ Phenoline 368 WG	B	3.8 7.2 2.3 9.4/8.9/7.8	None	None	None	None	None

l exhibited coating discoloration
enoline 368 Primer

* Panel suspended in vapor phase.

Appendix 1

Carboline Specification ST1

Steel Test Specimens

Panels: The size for carbon steel panels shall be 2 by 4 inches by 1/4 inch thick ± 0.1 inches with rounded edges and corners. The steel for each specimen shall meet the requirements of ASTM A36, "Standard Specifications for Structural Steel".

Carl Braun
Advanced Laboratory Technician
Testing Department

John Montle
Vice President
Technology

Yuly Korobov
Supervisor
Testing Department

Pressure PSIG
1 hour/div
17/sec/div
Temp °F
Temp °C
2-02840
3-30-92
899413-D
THE FOXBORO COMPANY
FOXBORO, MASS.
MON.
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THU.
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SAT.

[1971] X

April 14, 1976

TESTING PROJECT: 01418
Final Report: 12 Days

SUBJECT: Loss of Coolant Accident Testing of Carboline Nuclear Coating Systems according to the TVA Stride Curve.

REFERENCE: Tennessee Valley Authority (TVA) Stride Curve; Mr. Roger Tegtmeyer.

PURPOSE: To determine the acceptability of Carboline Nuclear Coating Systems when exposed to the TVA Stride Curve and evaluated according to ANSI N101.2, Section 4.5 as interpreted by Carboline.

CONCLUSIONS: After the 12 days of the TVA Stride Curve, the following coating systems are acceptable when evaluated according to ANSI N101.2, Section 4.5 as interpreted by Carboline:

1c Carbo Zinc 11/1c Carboline 290 WB Finish
1c Carbo Zinc 11/1c Carboline 191 HB
1c Carbo Zinc 11
1c Carbo Zinc 11/1c Phenoline 368 WG Finish
1c Carboline 295 WB Surfacer/2c Carboline X2191-154
1c Carboline 295 WB Surfacer/1c Phenoline 305 Finish
1c Carboline 195 Surfacer/1c Carboline 191 HB
1c Carboline 295 WB Surfacer/1c Carboline 290 WB Finish
(Please refer to "Results")

PROCEDURE:

A. Test Coupon

1. 2" X 5" X 1/4" Sandblasted Steel Panels with Rounded Edges and Corners.

2. 2" X 5" X 1" Concrete Blocks

B. Systems Tested — Dry Film Thickness

1. (Sandblasted Steel)
1c Carbo Zinc 11
1c Carboline 290 WB Finish

2. (Sandblasted Steel)
1c Carbo Zinc 11
1c Carboline 191 HB

3. (Sandblasted Steel)
1c Carbo Zinc 11

4. (Sandblasted Steel)
1c Carbo Zinc 11
1c Phenoline 368 WG Finish

Dry Film Thickness: Please refer to "Results"

From the Carboline Research & Development Laboratory

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TESTING PROJECT: 01418
Final Report: 12 Days

PROCEDURE: (Continued)

B. Systems Tested — Dry Film Thickness

5. (Concrete Block)
   1c Carboline 295 WB Surfacer
   2c Carboline X2191-154

Please refer to "Results"

6. (Concrete Block)
   1c Carboline 295 WB Surfacer
   1c Phenoline 305 Finish

7. (Concrete Block)
   1c Carboline 195 Surfacer
   1c Carboline 191 HB

8. (Concrete Block)
   1c Carboline 295 WB Surfacer
   1c Carboline 290 WB Finish

C. Cure Schedules

Carbo Zinc 11: Overnight at high humidity and 100°F (38°C).

Carboline 290 WB Finish: 2 days at 75°F (24°C).

Carboline 191 HB: 10 days at 75°F (24°C).

Phenoline 305 Finish: 3 to 4 days at 75°F (24°C).

Phenoline 368 WG Finish: 7 days at 75°F (24°C).

Carboline 295 WB Surfacer: 24 hrs. at 75°F (24°C).

Carboline X2191-154: 72 hrs. at 75°F (24°C).

Carboline 195 Surfacer: 72 hrs. at 75°F (24°C).

D. Test Environment

Tennessee Valley Authority Stride Curve; Project 4840-P, Specification 180-01-AB.

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TESTING PROJECT: 01418
Final Report: 12 Days

D. Test Environment (Continued)

1. Time - Temperature - Pressure Profile

Time	Temperature	Pressure
Initial	75°F (24°C)	Atmospheric
Initial to 1 Second	330°F (166°C) (Steam Blast)	38 psig.
1 Second to 10 Seconds	Decrease to 250°F (121°C)	29.7 psig.
10 Seconds to 7 Minutes	Decrease to 240°F (116°C)	25.3 psig.
7 Minutes to 108 Minutes	Decrease to 160°F (71°C)	Atmospheric
108 Minutes to 12 Days	Hold at 160°F (71°C)	Atmospheric

2. Water Chemistry

Chlorides (as Cl)	0.05 ppm
Boron (as BO_3)	0.1 ppm
pH	6 to 8 at 25°C

GRADING PROCEDURE: The test coupons were evaluated for performance in the following areas:

1. Material flaking off
2. Delamination between coats and/or peeling
3. Blistering of the topcoat
4. Chalking of the coating
5. Excessive cracking

Grading procedures specified in Report N101.2-1972 of the American National Standards Institute-Protective Coatings for Light Water Nuclear Reactor Containment Facilities.

4.5 Methods of Examining & Evaluating the Exposed Text Specimens

The dynamic and/or static elevated temperature-pressure and irradiation test panels shall be evaluated within 2 hours and again after 2 weeks after removal from the test chamber for the following surface defects: flaking, delamination and/or peeling, blistering and chalking. Defects listed in Subsections 4.5.1 through 4.5.4 shall be dealt with as follows:

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TESTING PROJECT: 01418
Final Report: 12 Days

4.5.1 Flaking. ASTM D772, Evaluating Degree of Resistance to Flaking (Scaling) of Exterior Paints, Part 21, American Society for Testing and Materials, Philadelphia, Pa. 19103. Flaking shall not be permitted.

4.5.2 Delamination and/or Peeling. Delamination and/or peeling shall not be permitted.

4.5.3 Blistering. Blistering shall be limited to a few, intact blisters, Size No. 4, ASTM D714, Standard Method of Evaluating Degree of Blistering of Paints, Part 21, American Society for Testing and Materials, Philadelphia, Pa. 19103. The number and size of blisters shall be recorded.

4.5.4 Chalking. ASTM D659, Standard Method of Evaluating Degree of Resistance to Chalking of Exterior Paints, Part 21, American Society for Testing and Materials, Philadelphia, Pa. 19103. Heavy chalking shall not be permitted.

Any other changes in coating properties which are not also associated with the separation, or the release, of coating from the substrate shall not be a cause for rejection.

Maximum Degree of Failure Allowable		ANSI N101.2-1972 Criteria (As interpreted by Carboline)
Flaking ASTM D772		10 (None)
Delamination or Peeling		None
*Blistering ASTM D714-56	Blister Size	Blister Density
	#2	None
*NOTE: A blister is not intact when it has resulted in coating being separated from the test coupon.	#4	Few
	#6	Medium
	#8	Medium-Dense
Chalking ASTM D659		8 (Light)

NOTE: Flaking, blistering and chalking are all evluated according to ASTM Standards, with a rating of 10 indicating that no failure was observed in the specific grading area.

From the Carboline Research & Development Laboratory

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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350 HANLEY INDUSTRIAL CT. ST LOUIS, MO 63144

TESTING PROJECT: 01418
Final Report: 12 Days

RESULTS:

Coating System and I. D.	Dry Film Thickness	Flaking	Delamination Or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
1A) 1c Carbo Zinc 11 1c Carboline 290 WB Finish *	3 mils 4 mils 7 mils	10	None	10	10	Slight Coating Discoloration	Acceptable
1B) 1c Carbo Zinc 11 1c Carboline 290 WB Finish	3 mils 4 mils 7 mils	10	None	#6 M-B, One side & Edges	10	One Crack in blister along edge; slight coating discoloration	Acceptable
2A) 1c Carbo Zinc 11 1c Carboline 191 HB*	3 mils 4 mils 7 mils	10	None	#8 M-B, Scribed Side	10	Slight Coating Discoloration	Acceptable
2B) 1c Carbo Zinc 11 1c Carboline 191 HB	3 mils 4 mils 7 mils	10	None	#8 F-B, Scribed Side	10	Slight Coating Discoloration	Acceptable
Perfect Performance ANSI N101.2-1972		10	None	#4 F to #8 MD	#8 (Light)	*Panels Suspended in Chamber	

TESTING PROJECT: 01418
Final Report: 12 Days

RESULTS:

Coating System and I. D.	Dry Film Thickness	Flaking	Delamination Or Peeling	Blistering	Chalking	Other Performance Characteristics	Performar Evaluatic
3A) 1c Carbo Zinc 11*	3 mils	10	None	10	10	Slight Surface Attack and Discoloration	Acceptabl
3B) 1c Carbo Zinc 11	3 mils	10	None	10	10	Slight Surface Attack on Zinc & Discoloration	Acceptabl
4A) 1c Carbo Zinc 11 1c Phenoline 368 WG Finish*	3 mils 4 mils 7 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
4B) 1c Carbo Zinc 11 1c Phenoline 368 WG Finish	3 mils 4 mils 7 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
5A) 1c Carboline 295 WB Surfacer 2c Carboline X2191-154*	20 mils 2 mils/ct 24 mils	10	None	10	10	Very Slight Coating Discoloration	Acceptabl
Perfect Performance ANSI N101.2-1972		10	None	#4F to #8 MD	#8 (Light)	* Panels Suspended in Chamber	

TESTING PROJECT: 01418
Final Report: 12 Days

RESULTS:

Coating System and I. D.	Dry Film Thickness	Flaking	Delamination Or Peeling	Blistering	Chalking	Other Performance Characteristics	Performan Evaluatio
5B) 1c Carboline 295 WB Surfacer 2c Carboline X2191-154	20 mils 2 mils/ct 24 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
6A) 1c Carboline 295 WB Surfacer 1c Phenoline 305 Finish*	20 mils 4 mils 24 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
6B) 1c Carboline 295 WB Surfacer 1c Phenoline 305 Finish	20 mils 4 mils 24 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
7A) 1c Carboline 195 Surfacer 1c Carboline 191 HB*	25 mils 4 mils 29 mils	10	None	10	10	Very Slight Coating Discoloration	Acceptabl
7B) 1c Carboline 195 Surfacer 1c Carboline 191 HB	25 mils 4 mils 29 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
Perfect Performance ANSI N101.2-1972		10	None	#4F to #8 MD	#8 (Light)	* Panels Suspended in Chamber,	

TESTING PROJECT: 01418
Final Report: 12 Days

RESULTS:

Coating System and I. D.	Dry Film Thickness	Flaking	Delamination Or Peeling	Blistering	Chalking	Other Performance Characteristics	Performan Evaluatio
8A) 1c Carboline 295 WB Surfacer 1c Carboline 290 WB Finish*	20 mils 4 mils 24 mils	10	None	10	10	Very Slight Coating Discoloration	Acceptabl
8B) 1c Carboline 295 WB Surfacer 1c Carboline 290 WB Finish	20 mils 4 mils 24 mils	10	None	10	10	Slight Coating Discoloration	Acceptabl
Perfect Performance ANSI N101.2-1972		10	None	#4 to #8 MD	#8 (Light)	* Panels Suspended in Chamber.	

Patrick D. Fisher

Patrick D. Fisher
Developmental Engineer
Testing Department

John F. Montle
Vice-President
Research & Developme

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2992/8994
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TEST.91477-1

LABORATORY TEST REPORT

197

TESTING PROJECT: 02927 **DATE:** June 10, 1993

REPORT #: One **TIME:** 14 Days **DATE OF GRADING:** 2/25/93; 3/11/93; 4/6/93; 4/13/93;4/20/93

TOTAL DESIGN TEST DURATION: 14 Days **REQUESTED BY:** Earl Bowry

TITLE: Radiation/DBA Testing for Commonwealth Edison Byron and Braidwood Nuclear Plants.

REFERENCE: Mr. Richard Netzel of Sargent and Lundy Co.; Mr. Jim Doyle of Sargent and Lundy Co.

PURPOSE: To evaluate maintenance systems for Byron and Braidwood Nuclear Plants.

BACKGROUND: During construction of the Commonwealth Edison Byron and Braidwood Plants, Carboline systems were applied to concrete (Carboline 195/Phenoline 305) and steel (Carbo Zinc 11 SG/Phenoline 305) surfaces. These original systems were primarily intended for construction conditions: abrasive blasted surfaces and spray application. Since then, it has become more important to use coatings which are conducive to operating conditions: minimal surface preparation, brush and roll application, lower solvent emission (charcoal contamination concerns), and self-priming single coat applications for steel.

This test evaluates maintenance oriented coating systems which are more practical for operating nuclear plants. The coatings selected for this test have properties which exhibit compatibility to existing coatings, contain less solvent than the construction products, and have application characteristics which can enhance productivity, reduce maintenance costs, and help lower radiation exposure of the applicators (through a single coat approach).

Carboline 890 and 801 are two coatings which have been tested and approved for other utilities for level 1 use over various substrates and aged coatings. Both can be applied direct to metal, as a self-priming topcoat.

Sanitile D250 is a water-borne epoxy which can be used over aged existing coatings. On steel surfaces it must be applied over a primer. In this test Carboline 893, a solvent based epoxy primer, is used.

Starglaze 2001 and Phenoline 305 were also included in the test program as floor maintenance coatings.

In designing the test, the following were considered:

The technical data furnished are true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

carboline

a) Aging of existing coatings were simulated by oven baking for two weeks at 150°F.
b) Surface preparation of aged existing coatings were simulated by hand sanding or solvent wiping.
c) Minimal surface preparation methods, SSPC-SP3, and SSPC-SP11 were used.
d) Effects of residual surfacer (195) or residual primer (Carbo Zinc 11 SG) were evaluated.
e) Wide film thickness ranges and multiple coat applications were incorporated to give wide application ranges and to consider future maintenance cycles.
f) Concrete damage and repair was simulated by using the Elcometer adhesion tester.
g) A 100% solids floor coating was included to provide another option for solvent sensitive applications.

F. Cure Schedule

Coating	Panel ID	Panel Side	Cure
	Concrete Blocks		
Starglaze 2000	61-64	A^1,C^1	Less than 1 day at ambient
Starglaze 2001	61-64	A^2,C^2 (Bottom A)	7-10 days ambient
Phenoline 305 Finish	61-64	$A^{1,2},B^1,C^2,D^1$	3 days at ambient; 14 days at 150°F; 20 days at ambient
	61,62	$A^{1,2},B^1,C^2$ D^2	27 days at ambient before 2nd LOCA (Including irradiation)
	63,64	$A^{1,2},B^1,C^2,D^2$	34 days at ambient before 3rd LOCA (Including irradiation)

[1,2,3] 1st, 2nd, 3rd coats.

G. Exposure:

Irradiation to $2x10^8$ rads at Sterigenics International, Tustin, California, followed by 320°F LOCA curve, vapor phase only.

A. Time - Temperature - Pressure Conditions

Time *	Temperature, F° *	Pressure, PSIG *
0 to 10 seconds	125° to 320°	0 to 50
10 to 180 seconds	320°	50
180 seconds to 5 minutes	320°> to 270°	50
5 minutes to 20 minutes	270°	50°
20 minutes to 1 day	270° > to 170°	27 > to 5
1st day to 7th day	170° > to 155°	5 to ambient

* These are theoretical values. Attached are graphs of theoretical and actual LOCA temperature and pressure curves and copies of chart recording for this test found on pages 168, 169, 170, 171, 172 and 173, Lab Book #370.

B. Water Chemistry

Spray solution was demineralized water with 2000 ppm boric acid buffered to 12 pH by means of the addition of the necessary amount of sodium hydroxide. Spray solution was replaced after 75 minutes with the same solution but adjusted with sodium hydroxide to pH 10.

Solution circulation started when solution reached a temperature of 250°F.

Testing Project: 02927
Report: One, 14 Days
Results:

June 10, 1993
Page 18

Grading Date: 2/25/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 2 HOUR GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
5	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	A	Top Left	2.5 3.4/3.6	None	None	None[1]	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	3.3/3.3	None	None	#4 Few Intact	#6
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.5 3.0/2.9	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	3.3/3.3	None	None	#8 Few Intact[2]	#6
	1c Carbo Zinc 11 SG/SP11 3c Carboline 890	B	Top Left	2.5 5.6/4.9/5.0	Noen	None	None	#6
	Rusted Steel/SP11 3c Carboline 890		Bottom Left	5.3/4.8/4.4	None	None	None	#6
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 3c Carboline 890		Top Right	2.5 3.7/5.5/4.1	None	None	None	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom Right	5.3/4.8/4.4	None	None	None	#6

320 2x10 vapor only

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase.

[1] #2 few intact at edge.

[2] #6 few intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

Grading Date: 2/25/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 2 HOUR GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
6	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	A	Top Left	2.6 6.0/6.7	None	None	None[1]	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.0.5.5	None	None	#4 Few Intact[1]	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.6 4.6/5.5	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	6.0/5.5	None	None	#6 Few Intact[1]	#8
	1c Carbo Zinc 11 SG/SP11 3c Carboline 890	B	Top Left	2.1 6.1/8.6/6.7	None	None	None	#6
	Rusted Steel/SP11 3c Carboline 890		Bottom Left	6.1/8.6/6.6	None	None	None	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 3c Carboline 890		Top Right	2.1 4.9/9.8/6.5	None	None	None	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom Right	6.1/8.6/6.8	None	None	None	#8

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase.

[1] (1) #4 intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

Grading Date: 2/25/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 2 HOUR GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
7	1c Carbo Zinc 11 SG/SP11 1c Carboline 890	A	Top Left	2.1 2.7	None	None	None	#6
	Rusted Steel/SP11 1c Carboline 890		Bottom Left	2.7	None	None	None	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 1c Carboline 890		Top Right	2.1 2.6	None	None	None	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom Right	2.7	None	None	None	#8
	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	B	Top Left	2.3 5.6/5.1	None	None	None	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.0/5.0	None	None	None	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.3 4.6/5.1	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right[1]	6.0/5.0	None	None	None	None

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase.

[1] Very slight coating erosion.

Testing Project: 02927
Report: One, 14 Days
Results:

Grading Date: 2/25/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 2 HOUR GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
8	1c Carbo Zinc 11 SG/SP11 1c Carboline 890	A	Top Left	2.4 6.8	None	None	None[1]	#6
	Rusted Steel/SP11 1c Carboline 890		Bottom Left	6.7	None	None	None[2]	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 1c Carboline 890		Top Right	2.4 6.1	None	None	None	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom Right	6.7	None	None	#4 Few Intact[1]	None
	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	B	Top Left	2.1 7.1/9.8	None	None	None	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.5/10.8	None	None	None	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.1 6.1/11.1	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	6.5/10.8	None	None	None	None

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

[1] #4 few intact at edge.
[2] (1) #4 intact at edge.

* Panels suspended in vapor phase.

Testing Project: 02927
Report: One, 14 Days
Results:

Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
5	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	A	Top Left	2.5 3.4/3.6	None	None	None[1]	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	3.3/3.3	None	None	#4 Few Intact	#6
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.5 3.0/2.9	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	3.3/3.3	None	None	#8 Few Intact[2]	#6
	1c Carbo Zinc 11 SG/SP11 3c Carboline 890	B	Top Left	2.5 5.6/4.9/5.0	None	None	None	#6
	Rusted Steel/SP11 3c Carboline 890		Bottom Left	5.3/4.8/4.4	None	None	None	#6
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 3c Carboline 890		Top Right	2.5 3.7/5.5/4.1	None	None	None	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom Right	5.3/4.8/4.4	None	None	None	#6

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase

[1] #2 few intact at edge.
[2] #6 few intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

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Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
6	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	A	Top Left	2.6 6.0/6.7	None	None	None[1]	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.0/5.5	None	None	#4 Few Intact[1]	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.6 4.6/5.5	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	6.0/5.5	None	None	#6 Few Intact[1]	#8
	1c Carbo Zinc 11 SG/SP11 3c Carboline 890	B	Top Left	2.1 6.1/8.6/6.7	None	None	None	#6
	Rusted Steel/SP11 3c Carboline 890		Bottom Left	6.1/8.6/6.6	None	None	None	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 3c Carboline 890		Top Right	2.1 4.9/9.8/6.5	None	None	None	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom Right	6.1/8.6/6.8	None	None	None	#8

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase

[1] (1) #4 intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

June 10, 1993
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Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
7	1c Carbo Zinc 11 SG/SP11 1c Carboline 890	A	Top Left	2.1 2.7	None	None	None	#6
	Rusted Steel/SP11 1c Carboline 890		Bottom Left	2.7	None	None	None	#8
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 1c Carboline 890		Top Right	2.1 2.6	None	None	None	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom Right	2.7	None	None	None	#8
	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	B	Top Left	2.3 5.6/5.1	None	None	None	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.0/5.0	None	None	None	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.3 4.6/5.1	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right[1]	6.0/5.0	None	None	None	None

Panels exhibited coating discoloration after irradiation, prior to LOCA test.
[1] Very slight coating erosion.

* Panels suspended in vapor phase

Testing Project: 02927
Report: One, 14 Days
Results:

Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #1; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
8	1c Carbo Zinc 11 SG/SP11 1c Carboline 890	A	Top Left	2.4 6.8	None	None	None[1]	#6
	Rusted Steel/SP11 1c Carboline 890		Bottom Left	6.7	None	None	None[2]	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 1c Carboline 890		Top Right	2.4 6.1	None	None	None	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom Right	6.7	None	None	#4 Few intact[1]	None
	1c Carbo Zinc 11 SG/SP11 2c Carboline 890	B	Top Left	2.1 7.1/9.8	None	None	None	#6
	Rusted Steel/SP11 2c Carboline 890		Bottom Left	6.5/10.8	None	None	None	None
	1c Carbo Zinc 11 SG/ SP2 (Wire Brush) 2c Carboline 890		Top Right	2.1 6.1/11.1	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom Right	6.5/10.8	None	None	None	None

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase

[1] #4 few intact at edge.

[2] (1) #4 intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

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Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #4; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
41	1c Carboline 893/SP1 2c Carboline 890	A	Top	4.6 3.1/4.2	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom	2.5/3.5	None	None	#2 Few Intact	#6
	1c Carboline 893/SP1 3c Carboline 890	B	Top	4.7 8.2/4.8/5.0	None	None	None[2]	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom	6.5/5.5/4.4	None	None	#4 Few Intact	#6
42	1c Carboline 893/SP1 2c Carboline 890	A	Top	5.0 8.0/6.1	None	None	None[2]	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom[1]	7.1/6.4	None	None	#2 Medium Intact	#6
	1c Carboline 893/SP1 3c Carboline 890	B	Top	5.2 7.6/7.9/6.9	None	None	None[3]	#6
	Rusted Steel/SP3 3c Carboline 890		Bottom	6.0/9.0/6.9	None	None	None	#6

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase.

[1] Hairline cracks throughout entire area.
[2] (1) #4 intact at edge.
[3] #4 few intact at edge.

Testing Project: 02927
Report: One, 14 Days
Results:

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Grading Date: 3/11/93

320°F LOCA (STEEL PANELS)*
GROUP #4; LOCA #1; 14 DAY GRADING

	Panel Identification and Coating System	Panel Side	Panel Area	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering	Chalking
43	1c Carboline 893/SP1 1c Carboline 890	A	Top	4.3 4.2	None	None	None[1]	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom	3.3	None	None	None	#8
	1c Carboline 893/SP1 2c Carboline 890	B	Top	4.7 8.0/6.7	None	None	None	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom	7.9/6.4	None	None	None	#6
44	1c Carboline 893/SP1 1c Carboline 890	A	Top	5.1 7.5	None	None	#6 Few Intact	#6
	Rusted Steel/SP3 1c Carboline 890		Bottom	7.3	None	None	None	#6
	1c Carboline 893/SP1 2c Carboline 890	B	Top	5.0 8.1/8.0	None	None	#4 Few Intact[1]	#6
	Rusted Steel/SP3 2c Carboline 890		Bottom	7.2/9.0	None	None	None	#6

Panels exhibited coating discoloration after irradiation, prior to LOCA test.

* Panels suspended in vapor phase.

[1] #8 few intact at edges.

LABORATORY TEST REPORT

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April 9, 1973

TESTING PROJECT: 4-1202
Final Report

SUBJECT: Evaluation of the Carbo Zinc 11/Phenoline 368 WG Finish coating system when exposed to LOCA test conditions specified under ANSI N101.2 and General Electric Mark III Containment.

REFERENCE: Mr. J. R. Lopata/Mr. J. R. Sasso, General Electric Company; ANSI N101.2-1972.

PURPOSE: To determine if the Carbo Zinc 11/Phenoline 368 WG Finish coating system will meet the performance criteria specified for a steel containment vessel lining under ANSI N101.2-1972, when exposed to an ANSI N101.2 suppression chamber and General Electric Mark III containment temperature-pressure curve composite.

CONCLUSION: The Carbo Zinc 11/Phenoline 368 WG Finish coating system meets the performance requirements when evaluated according to ANSI N101.2-1972, Section 4.5.

PROCEDURE:

A. Test Coupon
2" x 5" x 1/8" sandblasted steel.

B. Systems Tested

Systems Tested	Dry Film Thickness (DFT)
1c Carbo Zinc 11	3.5 mils
1c Phenoline 368 WG Finish	Please refer to "Results"

C. Cure Schedule
Carbo Zinc 11: 24 hours at high humidity plus long term storage at ambient.

Phenoline 368 WG Finish: 2 weeks at ambient.

D. Exposure
Composite temperature curve following the testing criteria specified under the General Electric Mark III containment and ANSI N101.2 suppression chamber vapor temperature.
Demineralized Water Test Solution under dynamic spray conditions.
The test coupons were subjected to the following time-temperature profile:

From the Carboline Research & Development Laboratory

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TESTING PROJECT: 4-1202
Final Report

PROCEDURE: (continued)

D. Exposure (continued)

Total Time Lapse	Temperature °F
Initial	70°F
1 second	100°F
10 seconds	135°F
1 min.,40 sec.	150°F
16 min., 40 sec.	160°F
2 hrs., 46 min., 40 sec.	190°F
3 hrs., 20 min.	235°F
27 hrs., 47 min.	190°F
End of Test	

The test panels were immersed approximately 1-1/2 inches into the solution inside the test chamber.

After being evaluated for this Interim Report, the test coupons were returned to the deionized water solution for exposure at 180°F. This is not a part of the above test criteria and is referred to in the Addendum.

GRADING PROCEDURE: The test coupons were evaluated for performance in the following areas:

1) Material flaking off
2) Delamination between coats and/or peeling
3) Blistering of the topcoat
4) Chalking of the coating
5) Excessive cracking

Grading procedures specified in Report N101.2-1972 of the American National Standards Institute-Protective Coatings for Light Water Nuclear Reactor Containment Facilities:

4.5 Methods of Examining and Evaluating the Exposed Test Specimens

The dynamic and/or static elevated temperature-pressure and irradiation test panels shall be evaluated within 2 hours and again after 2 weeks after removal from the test chamber for the following surface defects: Flaking, Delamination and/or Peeling, Blistering, and Chalking. Defects listed in Subsections 4.5.1 through 4.5.4 shall be dealt with as follows:

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TESTING PROJECT: 4-1202
Final Report

GRADING
PROCEDURE: (continued)

4.5.1 Flaking. ASTM D772, Evaluating Degree of Resistance to Flaking (Scaling) of Exterior Paints, Part 21, American Society for Testing and Materials, Philadelphia, Pa. 19103. Flaking shall not be permitted.

4.5.2 Delamination and/or Peeling. Delamination and/or peeling shall not be permitted.

4.5.3 Blistering. Blistering shall be limited to a few, intact blisters, Size No. 4, ASTM D714, Standard Method of Evaluating Degree of Blistering of Paints, Part 21, American Society for Testing and Materials, Philadelphia, Pa. 19103. The number and the size of blisters shall be recorded.

4.5.4 Chalking. ASTM D659, Standard Method of Evaluating Degree of Resistance to Chalking of Exterior Paints, Part 21, American Society of Testing and Materials, Philadelphia, Pa. 19103. Heavy chalking shall not be permitted.

Any other changes in coating properties which are not also associated with the separation, or the release, of coating from the substrate shall not be a cause for rejection.

	ANSI Criteria N101.2-1972
Flaking ASTM D772	10
Delamination or Peeling	None
Blistering ASTM D714	4F
Chalking ASTM D659	Light (8)

NOTE: Flaking is graded according to ASTM D772 with a rating of 10 indicating no flaking was observed.

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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April 9, 1973/Page 4.

TESTING PROJECT: 4-1202
Final Report

RESULTS:

	DFT	Flaking	Delamination and/ or Peeling	Blistering	Chalking
Panel A Carbo Zinc 11 Phen. 368 WG Fin.	3.5 9.0 12.5	10	None (1)	10	10
Panel B Carbo Zinc 11 Phen. 368 WG Fin.	3.5 10.0 13.5	10	None	10	10
ACCEPTABLE PERFORMANCE N101.2-1972		10	None	4F	8

(1) There is a hairline surface cracking on one side of Panel A, but the coating is intact at this time.

DISCUSSION OF RESULTS: The test coupons which were used for this evaluation were not pinhole free. Also, the coating had not been filtered before application and there were particles on the surface film.

The surface cracking on Panel A was observed through magnification. At this time, the coating system is completely intact and, therefore, protecting the steel substrate.

Daniel R. Leritz
Testing Department

DRL/lft
OR: Testing Department
XC: SLL
RRR
HDT
JFM
EWS
JDB
GHD
SLS
JRL
LAB GROUP LEADERS

From the Carboline Research & Development Laboratory

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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LABORATORY TEST REPORT

April 9, 1973

TESTING REPORT: 4-1202
ADDENDUM:

The test coupons will be returned to the immersion solution environment for 99 days at 180°F. This long term test exposure is an addition to, and not a part of, the ANSI N101.2 and General Electric Mark III containment exposure criteria.

Daniel R. Leritz
Testing Department

DRL/lft

From the Carboline Research & Development Laboratory

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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4-1202

TESTING DEPARTMENT REQUEST FORM

SUBJECT: LOCA Testing per G.E. Nuc. Pt. Containment and ANSI N101.2 Suppression Chamber.

REFERENCE: JRL; J.R. Sasso, General Electric Co.

PURPOSE: To evaluate the performance of: C24/Rhu 368WC when exposed to the "composite" test criteria called for in the above two specifications.

PROCEDURE:

A) Special Panels (2" x 5" panels standard)

Std

B) Systems Tested

1c Carbo Zinc 11, 3.5 mils

1c Rhenolin 368 WC, 6-7 mils

C) Exposures

The composite test curve exposure specified in the two temperature envelopes of the above specifications.

PROJECT TIMING:

SPECIAL REQUESTS: Demineralized Water Test Solution

Signed: [illegible]

Date: 3-27-73

Approved: [illegible] per TPM

Date:

Started 3/27/73 1:00pm

Time Lapse	3/27 1:00 pm	Temp. at "END" of time lapse
0 sec		70°F
1 sec		100°F
10 sec		135°F
1 min, 40 sec		150°F
16 min, 40 sec	3/27 1:16:40 pm	165°F
2 hrs, 46 min, 40 sec	3/27 3:46:40 pm	190°F
3 hrs, 20 min	3/27 4:20 pm	235°F
27 hrs, 47 min	3/28 4:47 pm out of test	190°F
— INTERIM REPORT — 100 days		180°F

TEMP CHG

~ Initial Temp.

Use Dynamic LOCA Apparatus

~~[illegible] Dl container will be [illegible] filled [illegible] O.P. H2 and [illegible] Dl + 100°F. The tube, now will be at ambient temp. After [illegible] the [illegible] and placed in an oven at temperature [illegible] to the [illegible]~~

Time Lapse	Temp Charged To:
16 min, 40 sec	190°F
2 hrs, 46 min, 40 sec	235°F
3 hrs, 20 min	190°F
27 hrs, 47 min	Test Complete. Samples removed and evaluated. —

carboline TESTING PROJECT # 4-1202 DISTRIBUTION

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REPORT DATE	EDITION	LENGTH TO DATE
4/9/73	Final	

TEST.91477-1

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TESTING DEPARTMENT ABSTRACT REPORT

TESTING PROJECT: 02851 **DATE:** November 13, 1992

REPORT #: Three **TIME:** **DATE OF GRADING:** 7/23/92

TOTAL DESIGN TEST DURATION: **REQUESTED BY:** Jerry Arnold/Earl Bowry

TITLE: Radiation/DBA Testing for Clinton Power Station - Unit 1
(Final Grading of Post DBA Irradiated Panels)

REFERENCE: See reports # One and # Two of this Testing Project (02851) for a full description of the DBA test and intermediate grading of the post-LOCA irradiated panels. This report covers only the final grading of the panels after they were irradiated to one final dose of $6x10^8$ rads (total $1x10^9$ rads). This grading was performed at Carboline by Carl Braun, Advanced Testing Technician of Carboline

PURPOSE: To evaluate maintenance systems for aged Carbo Zinc 11 SG/Carboline 191 HB and Carboline 195 Surfacer/Carboline 191 HB.

BACKGROUND: After the 14 day grading following the DBA exposure test it was determined that the pre-DBA irradiation of $2x10^8$ was not sufficient to satisfy the requirements of Clinton Power Station. A decision was made by Clinton personnel to have the already tested panels sent to SteriGenics and exposed to additional gamma radiation so that the total exposure (pre and post DBA accumulation) would total $1x10^9$. It was further determined that an intermediate grading at a dosage of $4x10^8$ would be made (See Report # Two). This report is of the final grading of those panels at the time of the $1x10^9$ exposure.

SYSTEMS: See Report # One of this test. (All coupons received an additional four month ambient cure prior to the additional $2x10^8$ irradiation).

EXPOSURE: Irradiated to $6x10^8$ rads at SteriGenics International (Tustin, CA). This raised the total accumulated dosage of these panels to $1x10^9$ rads.

CONCLUSIONS: See Summary of Results.

From the Carboline Research & Development Laboratory

The technical data furnished are true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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TEST-41982

Testing Project: 02851
Report: Three, 1x10[8] Irradiation
Summary of Results:

November 13, 1992
Page 4
Grading Date: 7/23/92

FINAL GRADING OF POST DBA IRRADIATED STEEL PANELS

Coating System	Dry Film Thickness, Mils	Flaking	Delamination or Peeling	Blistering: After LOCA[2] / After 4x10[8] Irradiation[3]	Blistering: After Final 1x10[8] Irradiation[4]	Cracking[4]	Chalking[4]
1c Carbo Zinc 11 SG/ Residual Zinc 1c Carboline 801	2.1 - 2.3 1.0 - 1.1[1] 6.6	None	None	#8 medium to #6 medium dense intact[2,3]	#8 medium to #6 medium dense intact with cracks	Hairline cracks over entire face	None
1c Carbo Zinc 11 SG/ Residual Zinc 2c Carboline 801	2.0 - 2.6 1.7 - 2.1[1] 6.0 - 8.1/coat	None	None	#4 few to #2 medium dense intact[2] Blisters cracked[3]	#4 medium to #2 dense intact with cracks	Hairline cracks over entire face	None to Slight
1c Carbo Zinc 11 SG/ Residual Zinc 3c Carboline 801	2.1 0.9 - 1.7[1] 4.4 - 8.4/coat	None	None	#2 medium dense intact[2] Blisters cracked (1 side)[3]	#2 medium dense to #2 dense intact with cracks	Hairline cracks over entire face	None to Slight
1c Carbo Zinc 11 SG/ Residual Zinc 1c Carboline 890	2.2 - 2.5 1.0 - 1.2[1] 5.6 - 5.9	None	None	#8 few intact[2,3]	#8 few intact to #8 medium intact with cracks	Hairline cracks over entire face	None to Slight
1c Carbo Zinc 11 SG/ Residual Zinc 2c Carboline 890	2.0 - 2.2 0.7 - 1.3[1] 3.6 - 7.2/coat	None	None	#8 few to #6 medium dense intact[2] Blisters cracked (2 sides)[3]	#6 medium to #4 medium dense intact with cracks	Hairline cracks over entire face	None
1c Carbo Zinc 11 SG/ Residual Zinc 3c Carboline 890	2.1 - 2.6 0.8 - 1.6[1] 3.0 - 6.4/coat	None	None	#6 medium intact[2] Blisters cracked[3]	#6 medium to #4 medium intact with cracks	Hairline cracks over entire face	None

Results are from two or four panel sides.
1 Dry film thickness after SP3 cleaning.
2 Results after LOCA.
3 Results after 4x10[8] Irradiation.
4 Results after 1x10[8] Irradiation.

LABORATORY TEST REPORT

TESTING PROJECT: 02851 **DATE:** March 19, 1992

REPORT #: One **TIME:** 14 Days **DATE OF GRADING:** 2/20/92

TOTAL DESIGN TEST DURATION: 14 Days **REQUESTED BY:** Jerry Arnold

TITLE: Radiation/DBA Testing for Clinton Power Station - Unit 1

PURPOSE: To evaluate maintenance systems for aged Carbo Zinc 11 SG/ Carboline 191 HB and Carboline 195 Surfacer/Carboline 191 HB.

BACKGROUND: During construction of the Clinton Plant, Carboline systems were applied to steel (Carbo Zinc 11 SG/Carboline 191 HB) and concrete (Carboline 195/Carboline 191 HB) surfaces. These original systems were primarily intended for construction conditions: abrasive blast surface preparation and spray application. Since then, it has become more important to use coatings which require less surface preparation (i.e., SP3), that can be brushed or rolled, and which contain less solvent than the original coatings.

This test evaluates maintenance oriented coating systems which are more practical for operating nuclear plants. The coatings tested meet the requirements for maintenance coatings discussed above and are compatible with the existing, aged coating systems.

In designing this test series, the following were considered:

a. Simulated aging of the original systems
b. Surface preparation of the aged coating system
c. Surface preparation of the exposed substrates
d. Effects of residual primer on surfaces on DBA performance
e. Multiple coat applications, taking into consideration future painting cycles
f. Simulated concrete damage and repair
g. 100% solids floor coatings

The test parameters (radiation, LOCA pressures, LOCA temperatures) were provided by the client, Illinois Power and its representative, Sargent & Lundy. Many of the panel preparation and DBA testing steps were monitored and witnessed by Henry Miller of Sargent & Lundy.

CONCLUSIONS: See Summary of Results.

The technical data furnished are true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied.

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PROCEDURE:

A. Test Coupons

Description: 2" x 4" x 1/4" steel, certified Carboline ST1 (see Appendix 1);

2" x 2" x 4" concrete blocks conforming to Carboline Specification CB2 (see Appendix 1).

Surface Preparation:

Steel Panels
Gritblasted to SSPC-SP10-82 with a 2.0 - 3.0 mil blast profile.

Concrete Blocks
Side A (Broom Surface) lightly brush-off blasted to SSPC-SP7-82 to remove laitance.
Sides B, C, D lightly wirebrushed to SSPC-SP3-82 to remove laitance.

Abrasive Medium: 50/50 mix of GFH #40 grit and S230 shot.

B. Systems Tested

Steel Panels: Coating	Panel No.	Batch Numbers Part A	Part B	Color	Thinner	Dry Film Thickness Range (Mils)
1c Carbo Zinc 11 SG	All	1H9468M	1H7447Z	Green 0300	TH#26(18%) 0M9925M	2.0-3.4
1c Carboline 191 HB	1A-8A	1J9497M	0J9799M	White S800	TH#15(18%) 0G9645M	6.0-7.0
1c, 2c, 3c Carboline 801	1A-4A[1] 9A-12A[2] 17A-20A[3] 25A-28A[4]	1J5350M	1H9441M	Gray R705	TH#4(10%) 0H9767M	4.7-8.8/coat
1c, 2c, 3c Carboline 890	5A-8A[1] 13A-16A[2] 21A-24A[3] 29A-32A[4]	1K9565M	1L9621M	Gray C703	TH#2(12%) 1H9482M	3.0-9.2/coat

[1] Panels 1A-8A: Top 1/2 of Carboline 191 HB panels solvent wiped; bottom 1/2 of Carboline 191 HB panels sanded with 80 grit sandpaper, then solvent wiped prior to application of Carboline 801 and Carboline 890.

B. Systems Tested

[2] Panels 9A-16A: Carbo Zinc 11 SG panels were washed with tap water prior to application of Carboline 801 and Carboline 890.

[3] Panels 17A-24A: Carbo Zinc 11 SG panels were gritblasted to SSPC-SP6-82, leaving residual zinc on substrate prior to application of Carboline 801 and Carboline 890.

[4] Panels 25A-32A: Carbo Zinc 11 SG panels were power-tool cleaned using a 3M Clean-N-Strip unitized wheel to SSPC-SP3-82 leaving residual zinc on substrate prior to application of Carboline 801 and Carboline 890.

Coating	Concrete Block No.	Side	Batch Numbers Part A	Part B	Color	Thinner	Theoretical Dry Film Thickness Range(Mils)
1c Carboline 195 Surfacer	All	All[1]	1K9397M	9M9255M	White 0800	TH#2(10%) 1A9014M	20.0
1c Carboline 191 HB	All	All	1J9497M	6J9799M	White S800	TH#15(12%) 0G9645M	4.0-6.0
1c Starglaze 2011S	49A-52A 57A-60A All	A[3] D[2]	1H9H51M Part C: 1F7413C	1G9422M	Gray	Unthinned	20.0
1c Starglaze 2000/			0K2937M	1L1484M	Clear 0910	Unthinned	5.0
1c Starglaze 2001	53A-56A	A[4]	1K9614M	1L9645M	Gray 2716	Unthinned	30.0
1c, 2c, 3c Carboline 801	49A-52A	A,B[5] C,D	1J5350M	1H9441M	Gray R705	TH#4(10%) 0H9767M	5.0-7.0
1c, 2c, 3c Carboline 890	57A-60A	A,B[5] C,D	1K9565M	1L9621M	Gray C703	TH#2(12%) 1H9482M	5.0-7.0
2, 3c 4c Carboline 191 HB	53A-56A	B[5] C,D	1J9497M	0J9799M	White S800	TH#15(12%) 0G9645M	4.0-6.0

[1] A flush coat of Carboline 195 Surfacer was applied to seal the pores of the concrete blocks prior to a full coat of Carboline 195 Surfacer.

[2] An Elcometer adhesion test was performed in the center on Side D of all concrete blocks. The hole produced from the adhesion pull was repaired with Starglaze 2011S.

[3] The top 1/2 of side A on all concrete blocks was power-tool cleaned, using a 3M clean-n-strip unitized wheel leaving residual Carboline 195 Surfacer. The bottom 1/2 of Side A was hand sanded with 80 grit sandpaper on blocks 49A-52A and 57A-60A, Side A was repaired with Starglaze 2011S prior to application of Carboline 801 and Carboline 890.

4 The top 1/2 of Side A on all concrete blocks was power-tool cleaned, leaving residual Carboline 195 Surfacer. The bottom 1/2 of Side A was hand sanded with 80 grit sandpaper on blocks 53A-56A. Side A was repaired with Starglaze 2000/Starglaze 2001.

5 Side B of all blocks was hand sanded with 80 grit sandpaper then solvent wiped prior to application of Carboline 861, Carboline 890 and second coat of Carboline 191 HB.

C. Cure Schedule

Coating	Panel ID	Panel Side	Cure
Steel:			
Carbo Zinc 11 SG	1A-8A	A,B	3 days @ 100°F 100% RH
	9A-32A	A,B	14 days @ 100°F 100% RH
Carboline 191 HB	1A-8A	A,B	14 days @ 150°F
Carboline 801 or Carboline 890	All	A^1, B^1	2 days @ 70-83°F 36-52% RH
	1A,2A,5A,6A 9A,10A,13A,14A 17A,18A,21A,22A, 25A,26A,29A,30A	A^1,B^2	3 days @ 150°F
		A^{2*},B^{3*}	17 days ambient conditions
	3A,4A,7A,8A, 11A,12A,15A,16A, 19A,20A,23A,24A, 27A,28A,31A,32A	A^{1*},B^{2*}	21 days ambient conditions
Concrete:			
Carboline 195 Surfacer Flush Coat	All	A,B,C,D	Overnight @ 70-82°F 41-83% RH
Build Coat	All	A,B,C,D	3 days @ 69-83°F 28-57% RH
Carboline 191 HB	All	A,B,C,D	14 days @ 150°F
Starglaze 2011S	All	D	3 days @ 68-83°F 35-52% RH
	49A-52A, 57A-60A	A	3 days @ 68-83°F 35-52% RH

Carboline 801 or Carboline 890	49A-52A	A^1,B^1,C^1,D^1	1 day @ 69-80°F 42-51% RH
	57A-60A	A^2,B^1,C^1,D^2	3 days @ 150°F
		$A^{2*},B^{1*},C^{2*},D^{3*}$	24 days ambient conditions
Carboline 191 HB	53A-56A	A,B^2,C^2,D^2	1 day @ 69-80°F; 42-51% RH
		A,B^2,C^2,D^3 B^{2*},C^{3*},D^{4*}	3 days @ 150°F 24 days ambient conditions
Starglaze 2000 Starglaze 2001	53A-56A	A	1 day @ 69-80°F; 42-51% RH
		A*	24 days ambient conditions

1,2,3,4 - 1st, 2nd, 3rd, 4th coats
* Final cure before and after LOCA

Please refer to Attachment "A" procedure for preparing test specimens.

D. Exposure

Irradiation to $2x10^8$ rads at Sterigenics International, Tustin, California, followed by 330°F LOCA curve, vapor phase only.

A. Time - Temperature - Pressure Conditions

Time*	Temperature, °F*	Pressure, psig*
0 to 1.5 sec.	135 to 330	0 to 30
1.5 to 40 sec.	330	30
45 sec. to 1 hr.	330 to 250	30 to 15
1 hr. to 1 day	250	15 to 5
1 to 7 days	250 to 100	5 to 0

* These are theoretical values. Attached are graphs of theoretical and actual LOCA temperature and pressure curves and copies of chart recordings for this test found on pages 158, 159, 160 and 161, Lab Book #370.

B. Water Chemistry

Deionized water. pH for steel panel LOCA: 8.39
pH for concrete block LOCA: 8.77

E. LOCA Grading Procedure
(ANSI N101.2-1972)

The test coupons are examined and evaluated within two hours and two weeks after removal from the test chamber for the following coating defects:

- o Flaking
- o Delamination and Peeling
- o Blistering
- o Chalking

There was no difference between two hour and two week gradings, except for concrete block 52-A, which exhibited one hairline crack near bottom on face A at 14 day grading.

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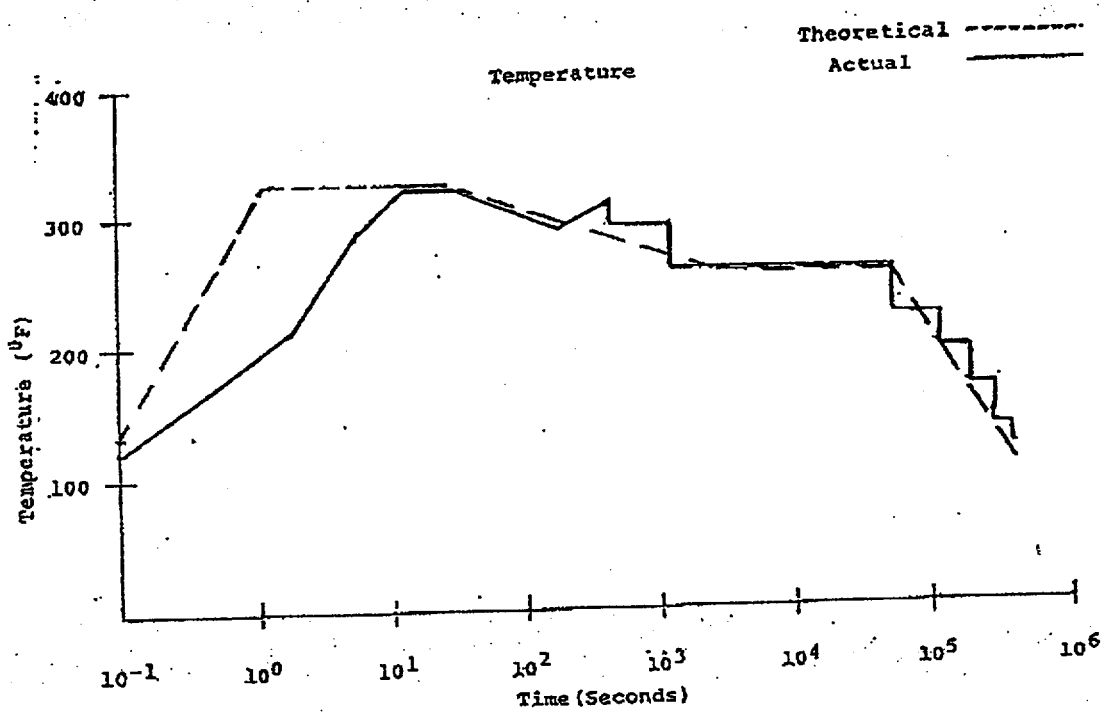
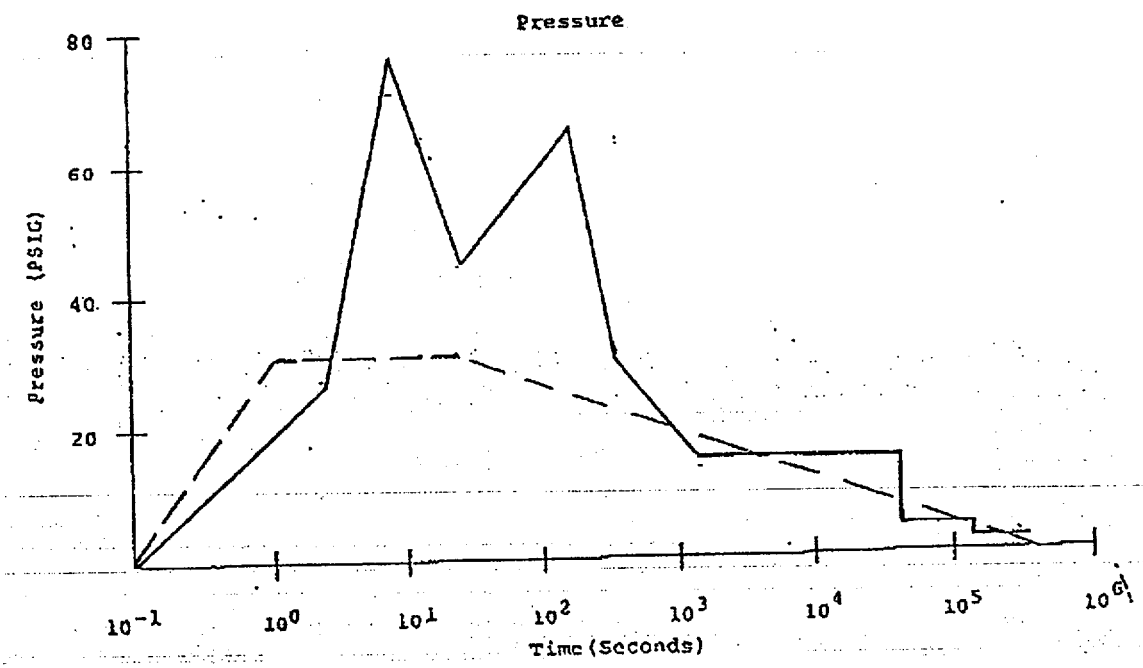
Steel Panels





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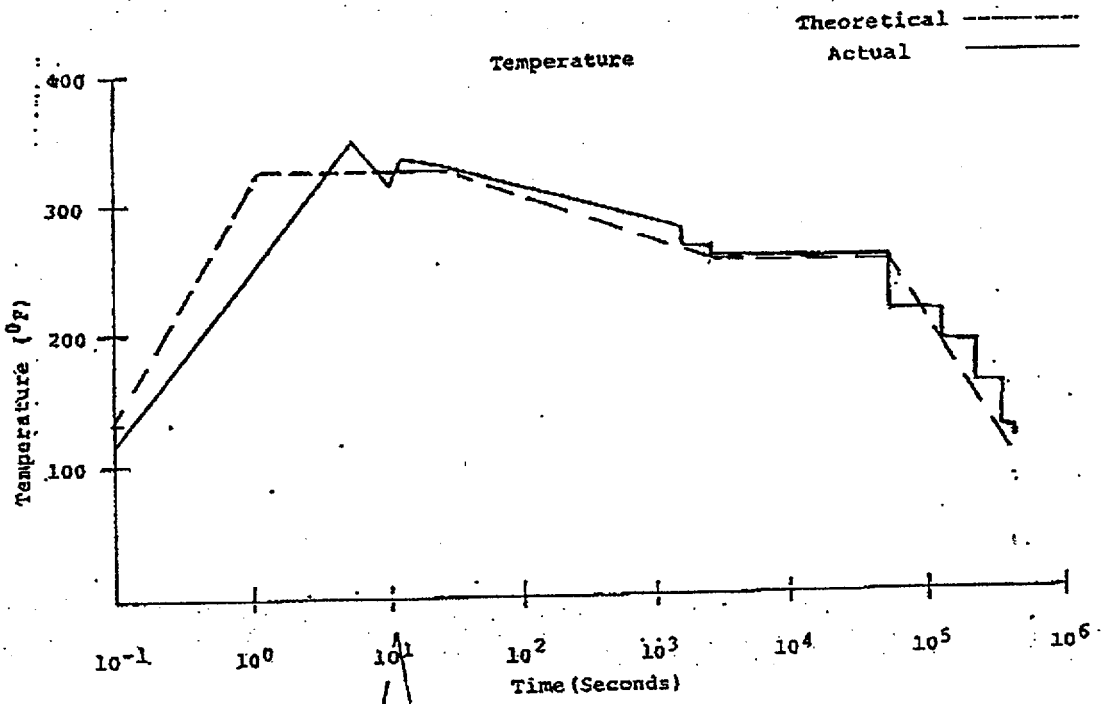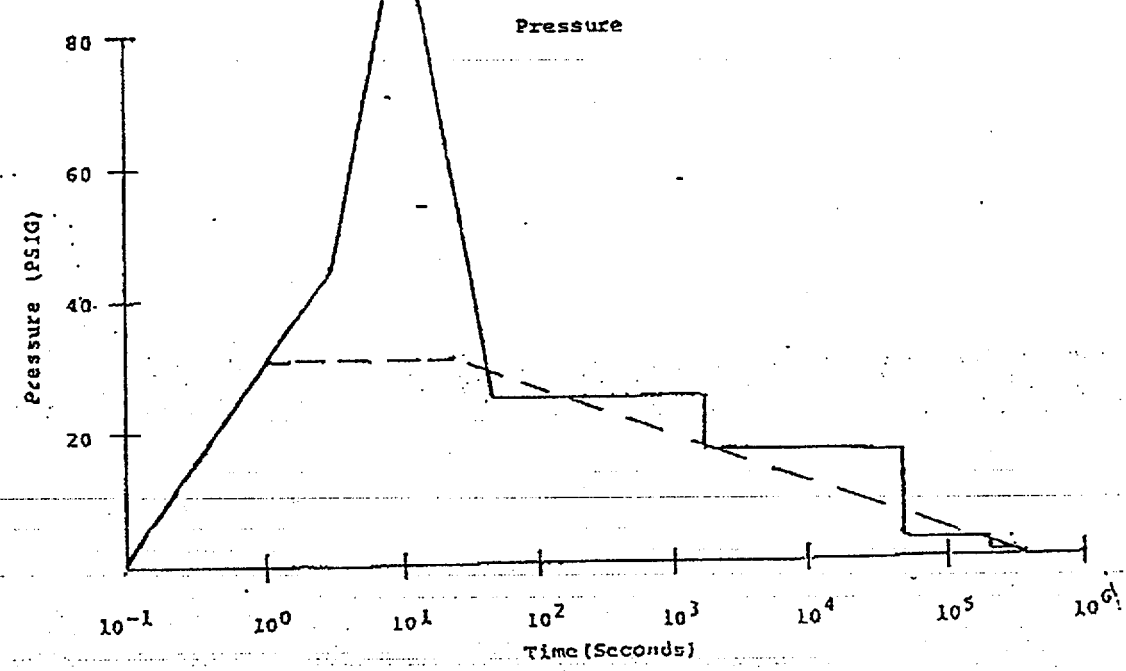
Concrete Blocks