

LABORATORY TEST REPORT

November 7, 1980

TESTING PROJECT: 01499.1
Final Report - 7 Days

SUBJECT: LOCA testing of Carbo Weld 11 with various topcoats.

REFERENCE: Mr. J. F. Montle; Bechtel CP-956-2/76

PURPOSE: To evaluate the performance of Carbo Weld 11 topcoated with Carboline 191 HB, Phenoline 305 Finish, Carboline 190 FD, and Phenoline 305 HB when exposed to the Bechtel CP-956-2/76 LOCA Curve.

CONCLUSIONS: After the 7 days of the Bechtel CP-956-2/76 LOCA Curve, the coatings tested exhibited the following performances when graded according to ANSI N101.2-1972, Section 4.5 as interpreted by Carboline:

<u>Coating System</u>	<u>Performance</u>
1c Carbo Weld 11/1c Carboline 191 HB	Acceptable
1c Carbo Weld 11/1c Phenoline 305 Finish	Acceptable
1c Carbo Weld 11/1c Carboline 190 FD	Acceptable
1c Carbo Weld 11/1c Phenoline 305 HB	Acceptable

PROCEDURE: A) Test Coupons

2" x 5" x 1/4" sandblasted steel panels with rounded edges and corners.

B) Systems Tested

Dry Film Thickness*

1)	1c Carbo Weld 11	1.5 mils
	1c Carboline 191 HB	4 to 6 mils
2)	1c Carbo Weld 11	1.5 mils
	1c Phenoline 305 Finish	4 to 6 mils
3)	1c Carbo Weld 11	1.5 mils
	1c Carboline 190 FD	4 to 6 mils
4)	1c Carbo Weld 11	1.5 mils
	1c Phenoline 305 HB	4 to 6 mils

*Please refer to "Results" for measured Dry Film Thickness.

C) Cure Schedule

Carbo Weld 11: 7 days minimum at 75°F (24°C), before topcoating. Carboline 191 HB, Phenoline 305 Finish, Carboline 190 FD, Phenoline 305 HB: 4 days minimum at 75°F (24°C), final cure. (Detailed film thickness, batch number and cure schedule records are available in the project file.)

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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PROCEDURE: (Continued)

D) Exposure

Bechtel CP-956-2/76 LOCA Curve

1. Time-Temperature-Pressure Curve

<u>Time</u>	<u>Temperature</u>	<u>Pressure</u>
Initial	Ambient	Ambient
Initial to 6 Hours	340°F (171°C)	70 psig
6 Hours to 96 Hours *	250°F (121°C)	30 psig
96 Hours to 7 Days	200°F (93°C)	10 psig

*After 6 hours of exposure, temperature of the test environment was reduced by spraying test solution at 75°F (24°C) into the test chamber which was at 340°F (171°C), giving a final temperature of 250°F (121°C).

2. Water Chemistry

0.28 Molar H_3BO_3 (3000 ppm Boron)

0.064 Molar $Na_2S_2O_3$

NaOH added to adjust to a pH of 9.5 at 77°F (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 topcoat
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 Subsection 4.5.1 through 4.5.4 shall be dealt with as follows:

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100 HANLEY ROAD, NEW CT. ST. LOUIS, MO 63104

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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 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.

ANSI N101.2-1972 Criteria
(As interpreted by Carboline)

Maximum Degree of Failure Allowable

Flaking ASTM D772	10 (None)										
Delamination or Peeling	None										
*Blistering ASTM D714-56	<table> <tr> <th>Blister Size</th><th>Blister Density</th></tr> <tr> <td>#2</td><td>None</td></tr> <tr> <td>#4</td><td>Few</td></tr> <tr> <td>#6</td><td>Medium</td></tr> <tr> <td>#8</td><td>Medium-Dense</td></tr> </table>	Blister Size	Blister Density	#2	None	#4	Few	#6	Medium	#8	Medium-Dense
Blister Size	Blister Density										
#2	None										
#4	Few										
#6	Medium										
#8	Medium-Dense										
Chalking ASTM D659	8 (Light)										

NOTE: Flaking, blistering and chalking are all evaluated 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

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RESULTS:

Coating System and I.D.	Dry Film Thickness	Flaking	Delamina- tion or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
1A)* Carbo Weld 11 Carboline 191 HB	1.4 mils <u>4.1 mils</u> 5.5 mils	10	None	10	10		Acceptable
1B) Carbo Weld 11 Carboline 191 HB	1.6 mils <u>4.6 mils</u> 6.2 mils	10	None	10	10		Acceptable
2A)* Carbo Weld 11 Phenoline 305 Finish	1.5 mils <u>3.0 mils</u> 4.5 mils	10	None	10	10		Acceptable
2B) Carbo Weld 11 Phenoline 305 Finish	1.6 mils <u>2.0 mils</u> 4.5 mils	10	None	10	10		Acceptable
Perfect Performance ANSI N101.2-1972		10	None	#4F to #8 MD	#8-Light	*Panels suspended in chamber.	

RESULTS:

Coating System and I.D.	Dry Film Thickness	Flaking	Delamina- tion or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
3)* Carbo Weld 11 Carboline 190 FD	1.5 mils <u>8.0 mils</u> 9.5 mils	10	None	#8 F-B	10		Acceptable
3B) Carbo Weld 11 Carboline 190 FD	1.5 mils <u>7.0 mils</u> 8.5 mils	10	None	10	10		Acceptable
4)* Carbo Weld 11 Phenoline 305 HB	1.5 mils <u>5.0 mils</u> 6.5 mils	10	None	#8 F-B	10		Acceptable
4B) Carbo Weld 11 Phenoline 305 Finish	1.5 mils <u>4.5 mils</u> 6.0 mils	10	None	#8 F-B	10		Acceptable
Perfect Performance ANSI N101.2-1972		10	None	#4E to #8 MD	#8-Light	*Panels suspended in chamber.	



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John F. Montle
Vice President
Research & Development

John J. Ladage, Jr.
Group Leader
Testing Department

nf:421

From the Carboline Research & Development Laboratory

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no guarantee of accuracy is given or implied.

carboline
100 PARKER INDUSTRIAL CT. ST. LOUIS, MO 63104

Manufacturer: Carboline
St. Louis, MO

Analytical Chemistry Division
Oak Ridge National Laboratory
Date: Aug. 16, 1978

Report of Irradiation, Decontamination, and DBA Testing

The irradiation, decontamination, and design basis accident (DBA) tests are conducted, respectively, in accordance with Bechtel Corp. Standard Specification Coatings for Nuclear Power Plants, spec. Nos. CP-951, CP-952, and CP-956 (or with modifications as noted in Table 2, DBA test conditions). The tests are designed also to meet the specifications set in both A.N.S.I. report N 101.2-1972, Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities, and N 5.12-1974, Protective Coatings (Paints) for the Nuclear Industry. The DBA test spray solution and the test conditions are listed in Tables 1 and 2. After both the DBA and the irradiation tests, the coatings are examined for signs of chalking, blistering, cracking, peeling, delamination, and flaking, according to ASTM standards where applicable. All except the decontamination test panels are returned to the coating manufacturer.

The irradiation tests are run using a spent fuel assembly, removed from the High Flux Isotope Reactor (HFIR) at ORNL, as the source of radiation. These fuel assemblies are stored under 20 feet of demineralized water. The fuel is 93% enriched U^{235} as U_3O_8 combined with aluminum. The spent fuel assemblies are removed after each 23-megawatt day period. Irradiation is done using the gamma energy from the accumulated mixed fission products. This more readily simulates conditions around a reactor than does a cobalt source. Also, the higher gamma activity affords shorter irradiation time to achieve accumulated doses. The dose rate four days after removal of a fuel assembly from the reactor is 1×10^6 rads/hour.

The fuel assembly is 20 inches high. A 20-foot long, 3-1/2-inch diameter pipe, with one end capped, is used for the air irradiation tests. The capped end is lowered into the four-inch opening of the center of the fuel assembly. The open end, above the water level, is covered with an "O" ring sealed flange to which is attached a steel cable and an air outlet hose. The air inlet is located at the bottom of the pipe. The test specimens are connected to the bottom of the cable and lowered into the

Evaluated J. J. G. King

Approved L. T. G. King

Manufacturer: Carboline
St. Louis, MO

Analytical Chemistry Division
Oak Ridge National Laboratory
Date: Aug. 16, 1978

radiation field. Also at the center of the fuel assembly is a stainless steel clad cadmium tube used as a neutron absorber. This prevents contamination of the test specimens by induced radiation.

The decontamination procedure is as follows: a mixture of fission product nuclides (aged greater than 90 days and less than three years) is neutralized to pH 4 and immediately applied to the test specimens. The specimens are previously degreased in alcohol. After the contaminated spot is air dried, the activities of four of the nuclides are measured by counting with a Ge(Li) detector and a multichannel pulse height analyzer. The specimens are then suspended in a beaker of water at 25°C and washed by stirring for 10 minutes. The specimens are removed, the backs rinsed in water, air dried, and counted as above. The ratios of the activities before, to those after the decontamination are reported as decontamination factors for water. The decontamination and counting steps in 25°C and 80°C acids are repeated, and the respective decontamination factors calculated. The "total overall D.F." is calculated as the ratio of the total activity at the beginning of the test to the total activity at the completion of the three washing steps. All activities are corrected for decay between counts. A computer has been programmed to do all the calculations.

Evaluated J. Bell

Approved K. T. Corbin

DECONTAMINATION TEST
TEST PANEL PREPARATION DATA

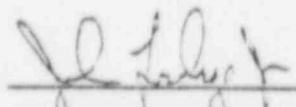
Test Report No. SR-116

DECONTAMINATION TESTBECHTEL CP-952 AND A.N.S.I. N-5.12TEST PANEL PREPARATION DATA

1. PRODUCT TO BE TESTED Carbo Zinc 11
2. TYPE SUBSTRATE Sandblasted Steel SIZE 2"x4"x1/4"
3. SURFACE PREPARATION (describe) SSPC-SP10-63 with a 1-3 mil blast profile
4. PRODUCT DATA: SAMPLE NO. (s) #140

<u>COAT</u>	<u>PRODUCT</u>	<u>PRODUCT CODES</u>	<u>BATCH #</u>	<u>APPLICATION METHOD</u>	<u>CONDITIONS R/M(°F)%R.H.</u>	<u>THICKNESS (ins.)</u>	<u>DATE APPLIED</u>
1c	Carbo Zinc	11	6H5937M 6G6100Z	Spray	68°/28%	.003/.003	11/12/76

5. CURING CONDITIONS: AMBIENT TEMP. 68-79 °F REL. HUMIDITY 20-38 %
MINIMUM CURE 17 DAYS
6. TEST PROCEDURE ORNL Master Analytical Method no.2 0920
7. TESTING PERFORM BY Analytical Chemistry Div. DATE SUBMITTED 11/29/76
Oak Ridge National Lab.


TEST REPORT NO. SR-116

DECONTAMINATION TEST RESULTS

Test Report No. SR-116

Manufacturer: Carboline
St. Louis, MO

Analytical Chemistry Division
 Oak Ridge National Laboratory
 Date: December 3, 1976

Decontamination Test Results:

These tests performed according to ORNL Master Analytical Manual
 Method No. 2 0920 and Bechtel Corp. Spec. CP-952.

ORNL Log Book No. A 7562; 11-29-6

Sample Number	Contaminant	Decontamination Factor (DF)				Percent of Total Activity Removed ¹
		Water @25°C	Acid @25°C	Acid @80°C	Overall	
#51 (SP-81)	Ce-144	4.8	4.5	1.9	41	97.0
	Ru-106	6.4	2.4	1.5	23	
	Cs-137	54	2.6	1.5	210	
	Zr-95	2.1	2.7	1.2	6.6	
	TOTAL	5.8	3.5	1.6	33	
#140 (CZ-11)	Ce-144	5.4	1.2	1.1	7.4	90.0
	Ru-106	7.8	1.3	1.2	12	
	Cs-137	76	1.9	2.0	290	
	Zr-95	3.0	1.4	1.2	5.1	
	TOTAL	6.9	1.3	1.1	10	
	Ce-144					
	Ru-106					
	Cs-137					
	Zr-95					
	TOTAL					
	Ce-144					
	Ru-106					
	Cs-137					
	Zr-95					
	TOTAL					

¹Percent of total activity removed = $(1 - \frac{1}{DF}) \times 100$

Approved L. T. Carbine



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SUBJECT: LOCA testing of Carbo Weld 11 with various topcoats.

REFERENCE: Mr. J. F. Montle; Bechtel CP-956-2/76

PURPOSE: To evaluate the performance of Carbo Weld 11 topcoated with Carboline 191 HB, Phenoline 305 Finish, Carboline 190 FD, and Phenoline 305 HB when exposed to the Bechtel CP-956-2/76 LOCA Curve.

CONCLUSIONS: After the 7 days of the Bechtel CP-956-2/76 LOCA Curve, the coatings tested exhibited the following performances when graded according to ANSI N101.2-1972, Section 4.5 as interpreted by Carboline:

<u>Coating System</u>	<u>Performance</u>
1c Carbo Weld 11/1c Carboline 191 HB	Acceptable
1c Carbo Weld 11/1c Phenoline 305 Finish	Acceptable
1c Carbo Weld 11/1c Carboline 190 FD	Acceptable
1c Carbo Weld 11/1c Phenoline 305 HB	Acceptable

PROCEDURE: A) Test Coupons

2" x 5" x 1/4" sandblasted steel panels with rounded edges and corners.

B) Systems Tested

Dry Film Thickness*

1)	1c Carbo Weld 11	1.5 mils
	1c Carboline 191 HB	4 to 6 mils
2)	1c Carbo Weld 11	1.5 mils
	1c Phenoline 305 Finish	4 to 6 mils
3)	1c Carbo Weld 11	1.5 mils
	1c Carboline 190 FD	4 to 6 mils
4)	1c Carbo Weld 11	1.5 mils
	1c Phenoline 305 HB	4 to 6 mils

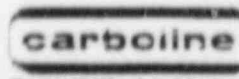
*Please refer to "Results" for measured Dry Film Thickness.

C) Cure Schedule

Carbo Weld 11: 7 days minimum at 75°F (24°C), before topcoating. Carboline 191 HB, Phenoline 305 Finish, Carboline 190 FD, Phenoline 305 HB: 4 days minimum at 75°F (24°C), final cure. (Detailed film thickness, batch number and cure schedule records are available in the project file.)

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PROCEDURE: (Continued)

D) Exposure

Bechtel CP-956-2/76 LOCA Curve

1. Time-Temperature-Pressure Curve

<u>Time</u>	<u>Temperature</u>	<u>Pressure</u>
Initial	Ambient	Ambient
Initial to 6 Hours	340°F (171°C)	70 psig
6 Hours to 96 Hours *	250°F (121°C)	30 psig
96 Hours to 7 Days	200°F (93°C)	10 psig

*After 6 hours of exposure, temperature of the test environment was reduced by spraying test solution at 75°F (24°C) into the test chamber which was at 340°F (171°C), giving a final temperature of 250°F (121°C).

2. Water Chemistry

0.28 Molar H_3BO_3 (3000 ppm Boron)

0.064 Molar $Na_2S_2O_3$

NaOH added to adjust to a pH of 9.5 at 77°F (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 topcoat
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 Subsection 4.5.1 through 4.5.4 shall be dealt with as follows:

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THE CARBOLINE INDUSTRIES, INC. 37 CARBOLINE AVE. ALBANY, N.Y. 12204



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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 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.

ANSI N101.2-1972 Criteria
(As interpreted by Carboline)

Maximum Degree of Failure Allowable

Flaking ASTM D772		10 (None)
Delamination or Peeling		None
*Blistering ASTM D714-56	<u>Blister Size</u>	<u>Blister Density</u>
	#2	None
	#4	Few
	#6	Medium
	#8	Medium-Dense
*NOTE: A blister is not intact when it has resulted in coating being separated from the test coupon.		
Chalking ASTM D659		8 (Light)

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

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100 PARKWAY - HOLISTON, MA 01926 - 508-548-1200

Testing Project: 01499.1
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RESULTS:

Coating System and I.D.	Dry Film Thickness	Flaking	Delamina- tion or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
1A)* Carbo Weld 11 Carboline 191 HB	1.4 mils <u>4.1 mils</u> 5.5 mils	10	None	10	10		Acceptable
1B) Carbo Weld 11 Carboline 191 HB	1.6 mils <u>4.6 mils</u> 6.2 mils	10	None	10	10		Acceptable
2A)* Carbo Weld 11 Phenoline 305 Finish	1.5 mils <u>3.0 mils</u> 4.5 mils	10	None	10	10		Acceptable
2B) Carbo Weld 11 Phenoline 305 Finish	1.6 mils <u>2.0 mils</u> 4.5 mils	10	None	10	10		Acceptable
Perfect Performance ANSI N101.2-1972		10	None	#4F to #8 MD	#8-Light	*Panels suspended in chamber.	

RESULTS:

Coating System and I.D.	Dry Film Thickness	Flaking	Delamina- tion or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
3)* Carbo Weld 11 Carboline 190 FD	1.5 mils <u>8.0 mils</u> 9.5 mils	10	None	#8 F-B	10		Acceptable
3B) Carbo Weld 11 Carboline 190 FD	1.5 mils <u>7.0 mils</u> 8.5 mils	10	None	10	10		Acceptable
4)* Carbo Weld 11 Phenoline 305 HB	1.5 mils <u>5.0 mils</u> 6.5 mils	10	None	#8 F-B	10		Acceptable
4B) Carbo Weld 11 Phenoline 305 Finish	1.5 mils <u>4.5 mils</u> 6.0 mils	10	None	#8 F-B	10		Acceptable
Perfect Performance ANSI N101.2-1972		10	None	#4F to #8 MD	#8-Light	*Panels suspended in chamber.	



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John F. Montle
Vice President
Research & Development

John J. Ladage, Jr.
Group Leader
Testing Department

nf:421

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