LOUISIANA POWER & LIGHT CO

WATERFORD SES NO. 3

REPORT ON LICENSE CONDITION NO. 16

EVALUATION OF THE POTENTIAL ADVERSE EFFECTS OF THE FAILURE OF CONTAINMENT COATINGS ON POST ACCIDENT FLUID SYSTEMS

REVISION 1

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

I. INTRODUCTION

The Waterford-3 Operating License (NPF-26, dated December 18, 1984) has a License Condition (Section 2.C.16) that states the following:

> "Prior to January 18, 1985, the licensee shall provide for staff review and approval an evaluation of the potential adverse effects of the failure of coatings inside of containment on post accident fluid systems."

On January 17, 1985 (Reference 5), the initial version of this report was submitted to the NRC to provide the evaluation specified by the License Condition. On February 11, 1985 a meeting was held with the NRC to discuss the submittal. As a result of that meeting, a February 27, 1985 letter (Reference 6) was sent to the NRC clarifying certain aspects of the report and committing to provide certain confirmatory information requested by the NRC. This revision includes information provided in the February 27, 1985 letter as well as the confirmatory information.

II. CONCLUSIONS

An evaluation of the potential adverse effects of the failure of coatings inside containment on post accident fluid systems was performed. Highly conservative assumptions were postulated in the evaluation. The evaluation determined that the Safety Injection System (SIS) and the Containment Spray System (CSS) will remain functional given the most conservative coating failure conditions. The far field and near field effects of coating failure were evaluated. The evaluation determined that pool velocities far from the SIS Sump are insufficient to transport coating particles to the SIS Sump region. Therefore, the SIS Sump screens are not susceptible to any clogging due to the far field effect of coating failure. The evaluation also determined that the near field effect of coating failure, coating falling into an area of the SIS Sump surface between 2.04 ft. and 3.42 ft. from the screen, results in about 34-1/2 percent of the vertical SIS screen area remaining unclogged (Two-Dimensional Analysis). This unclogged area is more than sufficient to prevent pump suction inlet vortexing and to provide for adequate Net Positive Suction Head (NPSH) to ensure proper pump operation.

The secondary effects of the ingestion of paint chips by post accident fluid systems were also evaluated. The evaluation determined that there are no components in the post accident fluid systems that are susceptible to degradation resulting from paint debris. This part of the evaluation was predicated on the assumption that paint chips could reach the SIS Sump screen, pass through the screen, and enter the post accident fluid systems. The evaluation covered the SIS, CSS, and NSSS.

Finally, the additional potential clogging due to insulation debris was evaluated. The findings indicate that there is no potential for SIS Sump blockage due to insulation debris.

III. QUALIFICATION OF PAINT

General

The protective coating systems and the applications at Waterford Unit 3 are considered to be substantially qualified, and the measures and corrective actions previously taken by LP&L provide substantial assurance that the paint coating system will not fail under DBA conditions.

FSAR Section 6.1.2.1 and FSAR Table 6.1-3 (Reference 2) and LP&L's response to NRC Question 281.2 (Reference 2) describe LP&L's program for, and inventories of, protective coatings. The NRC reviewed this information and concluded in SSER 1 that the protective coating systems and the applications were acceptable and met the requirements of 10CFR50, Appendix B.

Coatings DBA Tested and Qualified

LP&L conducted an evaluation of the paint coatings inside containment and determined that paint coatings applied to significant surface areas inside the containment are in substantial compliance with ANSI N101.2, N5.12, and N101.4. These paint coatings were tested and qualified under DBA conditions. The coatings were evaluated at independent laboratories or at the coating manufacturer's laboratories for stability, radiation, chemical, and fire effects in accordance with the requirements of ANSI N5.12 and N101.2. Also, the Quality Assurance during the manufacturing, transportation, and storage for field coating work was in compliance with ANSI N101.4, in conjunction with the general QA requirements of ANSI N45.2. Coatings applied to the approximately 91,900 ft^2 of steel containment vessel plates and the approximately 269,950 ft^2 of uninsulated piping and structural steel were tested and qualified under DBA conditions.

In addition, all coatings applied to concrete surfaces (approximately 82,824 ft^2) are in total compliance with ANSI N101.2, N5.12, and N101.4. These paint coatings were tested and qualified under DBA conditions.

Coatings Not DBA Tested and Not Qualified

The only source of paint coatings that LP&L considers not fully qualified are those paint coatings applied to equipment purchased prior to LP&L's commitment (March 1975) to the NRC Green Book, WASH-1309. These paint coatings were not DBA tested and did not require QA compliance. These paint coatings, however, were evaluated and were determined to be adequate for the intended function as recommended by the manufacturer. The application in the shop was done in accordance with a written procedure as submitted for review and approval. Further, paint coatings applied to equipment in this category received an evaluation as soon as the equipment was delivered to the site, and where necessary, qualified coatings were reapplied in accordance with Regulatory Guide 1.54. Approximately 13,950 ft^2 of paint coatings received this level of evaluation and were applied to various equipment inside containment.

Corrective Measures

Substantial corrective measures have been taken by LP&L to correct any deficiencies in the paint coatings.

Coating problems identified by Sline Industrial Painters Incorporated were documented in Ebasco Nonconformance Report W3-3648 and corrected by LP&L. LP&L directed Ebasco to conduct an evaluation of the entire coating system inside the Containment vessel. A thorough inspection and repair plan of the coating system was developed and fully implemented by LP&L and Ebasco. All defective areas were marked, hand tool cleaned, or blast cleaned and recoated using approved specifications and procedures in accordance with ANSI N101.2, N5.12, and N101.4. The inspection and repair actions taken by LP&L were reported to the NRC in Significant Construction Deficiency (SCD) 56.

In addition, an in situ DBA test was conducted. Three containment liner surface areas were selected. Steam was applied on each area enclosed by a chamber at temperatures and pressures simulating DBA values. Also, borated water simulating the Containment Spray solution was poured into the chamber and allowed to come in contact with the paint coating. The paint coating surface area was examined after the test, and the coating system did not exhibit any failures. The in situ test and results were also reported to the NRC in SCD 56.

The NRC, based on the foregoing corrective actions, documented full closure of SCD 56 in Inspection Report 84-24, dated July 3, 1984.

Amount of Paint Assumed to Fail

A total of 1745 ft^2 of paint was assumed to fall into the near field critical area as defined in the Two-Dimensional Analysis (Section VII). This was based on the assumption that all paint directly above the near field critical area would fall into the near field critical area. As a benchmark only about 13,950 ft^2 of the Containment paint is considered by LP&L not to be qualified. The Two-Dimensional Analysis showed that approximately 99.5 percent of the assumed failed paint would fall in the far field regions of the Containment (Section VII). Therefore, only about 0.5 percent or about 70 ft^2 of the paint considered by LP&L not to be qualified (compared to 1745 ft^2 assumed in the analysis) could be available to fall in the near field critical area. Further, a significant amount of the paint dislodging directly above the near field region would be captured or blocked by intervening grating floors or structures.

IV. PAINT FAILURE MODES

Laboratory DBA simulated tests conducted by the Carboline Company and the Ameron Company on the coating systems used on the steel surfaces of the Waterford 3 Containment Building showed that the systems would satisfactorily perform under DBA conditions.

Sample reports of tests conducted by the Carboline Company (Attachment 1) on the Carbozinc II/Phenoline 305 system and by the Ameron Company (Attachment 2) on the Amercoat 71/90 system, indicate that the systems performed in an acceptable manner. The mode of failure found was by blisters or cracking and not by flaking or delamination. Therefore, if any failure occurs at the Waterford 3 site, it is expected to be in the form of blisters.

This has been further confirmed by a letter from Ameron (Attachment 3) and by telecons with Mr. J. Montle, Technical Vice President of the Carboline Company (Attachment 4) and Mr. R. Brooksbank of the Oak Ridge National Testing Laboratory. (Attachment 5).

LP&L's evaluation of the failure mode indicates that the paint chip sizes would range between 1/8" and 1" (0.125" to 1"). The area where the coating may disbond is the area of the blister and the largest size blister that is acceptable in a simulated DBA test is a No. 4 blister (per ASTM D714). In addition, as shown in the attached telecons with Messrs Montle and Brooksbank, they indicated that based on their evaluation of the mode of failure, the paint chip size would range between 1/16" and 1" (0.0625" to 1"). This is very close to the range indicated in the TUGCO Report (Reference 1), Section 3.1, which gives a range of 1/8" to 1" (0.125" to 1"). Paint chips smaller than those indicated above are not expected to fall off as the topcoats are water insoluble epoxy compounds which will not fail in powder form. Any chips that fall off are of a brittle nature and will not fold.

In order to provide NRC with a conservative worst-case scenario, it was assumed that the paint particle size is 0.078" for conducting the SIS Sump blockage analysis. If the smallest size (0.0625") is used in calculating V_{Slide} the only value change to Equation 2 of Section VI is d (0.0625" versus 0.078") which gives a V_{Slide} of 0.161 ft/sec. V_{Tumble} is not dependent on particle size (but on particle thickness) and thus is unchanged. In addition, the Two-Dimensional Analysis in Section VII does not depend on particle size (but on particle thickness) and thus its conclusions are unchanged. Therefore, the conclusions of Sections VI and VII would not be affected if the paint particle size were assumed to be 0.0625" instead of 0.078".

The amount of paint available for ingestion by the RCS and the reactor core was determined by assuming that the paint coating failed in particles, all being 0.078" in size, and would pass through the SIS Sump vertical screens. This assumption thus provided a conservative basis for the ingestion evaluation.

Based on the above test results and evaluation, LP&L considers the possibility of paint particles clogging the SIS Sump and degrading its performance and the performance of any paint systems to be non-existent.

V. ASSUMPTIONS USED IN ANALYSIS

The coating materials in the Containment at Waterford 3 are expected to withstand the service conditions during normal plant operation and post-LOCA operations. However, it is postulated that all the coating materials except coatings on the concrete surfaces inside the containment (which was applied to the requirements of ANSI N101.2, N5.12 and N101.4) would fail during a LOCA. This assumption, although unrealistic, provides a conservative groundwork for an analytical evaluation of the effects of the coating failures on plant safety systems.

For the SIS Sump blockage analysis, another extremely conservative and equally unrealistic worst case assumption was made for the particle size distribution of the failed paint. For the paint debris transport analysis, it was assumed that all the paint fails as 0.078" diameter disk shaped particles. This is the smallest particle size which cannot pass through the SIS Sump screens and is more transportable than larger particles.

The SIS and the CSS will not be placed into recirculation mode operation immediately after a LOCA as the ECCS and the CSS will be initially operated in injection mode using water from the Refueling Water Storage Pool. The SIS and the CSS will be switched to recirculation mode at the completion of the injection mode at which time the Containment floor will be flooded with water. The minimum flooded water level was determined as El. -3.67' and the maximum flooded level at El. +0.5'(Figure 3).

The SIS Sump blockage can be analyzed by dividing the work into far field effects and near field effects. Far field effects concern paint and insulation that may be carried from anywhere in the Containment to the immediate sump region and then clog the SIS Sump screens. Near field effects concern only paint falling in a region adjacent to the SIS Sump screens, from which calculations show that the paint could reach the screens and clog the vertical screen surfaces.

VI. EVALUATION OF FAR FIELD PAINT EFFECTS

At the initiation of the recirculation phase of the post-LOCA operation, dislodged paint is subject to a circulating water flow. Fluid velocity, debris density, and debris size were analyzed to determine if debris transport occurs.

Paint Transport Velocity

The transport velocity for paint particles was derived following the basic concepts of NUREG/CR-2791 (Reference 4). In addition, the assumptions and derivations for generalized motion and transport of paint particles, that were developed in the Texas Utilities Generating Company (TUGCO) Report (Reference 1), were utilized. As shown in the TUGCO Report, with a model of forces balanced on a paint particle, the critical water velocity to initiate tumbling of a paint particle can be expressed as:

$$V_{Tumble} = \left[\frac{\mu_s(\rho_p - \rho_w)\ t\ (2g_c)}{C_D\ \rho_w}\right]^{0.5} \qquad (1)$$

where:

μ_s = static friction coefficient
ρ_p = density of paint
ρ_w = density of water
t = thickness of particle
g_c = Newton's constant
C_D = drag coefficient

Similarly, the critical water velocity to initiate sliding of a paint particle can be shown as:

$$V_{slide} = \left[\frac{\mu_d\ (\rho_p - \rho_w)\ (\pi\ d/4)\quad (2g_c)}{(1+\mu_d)\ \ C_D\ \rho_w}\right]^{0.5} \qquad (2)$$

where:

d = diameter of particle
μ_d = dynamic friction coefficient

and the remaining parameters were the same as defined with Equation 1. In addition, in the TUGCO Report, a sensitivity study was done on the

paint particle size, density drag coefficient and friction coefficient. The following conclusions were drawn from the study:

(a) The thickness of the paint particle has no effect on its transport velocity.

(b) The smaller the paint particle size, the higher the potential for its transport.

(c) The greater the relative density difference between the paint particle and the moving water, the lower the potential for transport.

(d) The higher the drag coefficient between the paint particle and the moving water, the higher the potential for transport.

(e) Variation in the friction coefficient between paint particle and concrete floor of the Containment does not significantly affect the transport velocity.

The paint particle size was assumed conservatively to be 0.078 inch, the smallest size that could clog the SIS Sump screens. The critical water velocities to initiate tumbling and sliding of this small paint particle were determined as:

$$V_{Tumble} = 0.074 \text{ ft/sec}$$

$$V_{Slide} = 0.181 \text{ ft/sec}$$

In the calculation, the following conservative data were used:

$$t = 0.005 \text{ in.}$$

$$\rho_p = 82.3 \text{ lbm/ft}^3$$

$$\rho_w = 60 \text{ lbm/ft}^3 \text{ (at 200°F)}$$

$\mu_s = 0.6$

$C_D = 1.1$

$\mu_d = 0.42$

The paint thickness and density are based on data in Table 1 and the SIS Sump water temperature is a conservative estimate at the time of SIS/CSS recirculation. The friction and drag coefficients are the typical values used in the TUGCO study.

For the purpose of performing a simple, yet still conservative evaluation of the far field effects, it is further assumed that all the failed paint will find its way down to the Containment floor (El. -11') since all the upper elevation floors are gratings. By making this assumption it is only necessary to evaluate several critical locations at El.-11'. To calculate the local water velocity at the selected critical locations, the flow rates shown in FSAR Table 6.3-4 (Reference 2) for the SIS and CSS during long-term recirculating mode were used. Four Regions, A, B, C and D, with potentially higher local velocities were identified in Figure 1. Regions A and D were considered to see whether any paint debris can be transported from the First and Second Quadrants to the Third and Fourth Quadrants. Regions B and C were considered to determine whether any paint debris from the Third and Fourth Quadrants can be transported to the near sump regions (for potentially clogging the SIS Sump screens). In calculating the maximum local velocities at the given region, the break is always considered near the given region to determine the highest value, while the Containment Spray flow is assumed to be uniformly distributed inside the Containment. The maximum local velocity in Regions A and D is calculated as 0.126 ft/sec; Region B is 0.105 ft/sec; and Region C is 0.252 ft/sec. Since all the tumbling debris will eventually orient itself such that the maximum surface area is oriented parallel to the Containment floor (Reference 4), the critical slide velocity becomes the governing parameter for the debris transport along the Containment floor. By comparing the local water velocity against the critical slide velocity (0.181 ft/sec) and the critical tumble velocity (0.074 ft/sec) calculated earlier it can be concluded that although paint

debris in Regions A, B and D can be tumbled by the water flow, it will not be transported to the other regions. Only the paint debris falling into Region C can possibly be transported into the region near the SIS Sump. However, based on the near field effects evaluation, the velocity at 3 feet away from the screens is merely 0.0227 ft/sec which would not even tumble the smallest paint debris assumed. Therefore, paint debris being transported from Region C to the region near the SIS Sump will settle at least 3 feet away from the SIS Sump screens and will not be transported further to clog the screens. Even if it is assumed that paint debris in Region C can be transported toward the SIS Sump screens, the TSP baskets (Section V) around the SIS Sump would block the paint debris from reaching the screens. Consequently, it is concluded that the SIS Sump screens will not be clogged by any paint debris falling into the far field regions.

VII. EVALUATION OF NEAR FIELD PAINT EFFECTS

This section of the report summarizes the results of the analysis done to study the behavior of paint fragments that become dislodged in the event of paint failure and fall to the surface of the pool of water surrounding the SIS Sump during the post-LOCA recirculation mode.

Introduction

Motion of paint fragments through a pool of water is affected by many parameters, including fragment size, shape, density, and water velocity. For the purpose of this analysis, conservative assumptions (which allow for maximum clogging of the sump screens) were made. These include the following:

(1) All paint covering the Containment dome, structural steel, and uninsulated piping is considered capable of falling off. A list is provided in Table 1.

(2) The top of the SIS Sump screen is completely clogged. Only the sides of the screen are available.

(3) The failed paint is uniformly distributed throughout the Containment.

(4) The paint detaches as particles shaped like a disk, with a diameter equal to the minimum hole size in the SIS Sump screen at the minimum thickness and minimum density possible.

(5) The maximum drag coefficient possible acts on the paint particles to minimize the settling velocity.

(6) The paint particles are horizontally oriented as they travel through the pool to minimize the settling velocity.

(7) Paint motion is assumed to be the type of motion with constant angle - this is used to get the paint vertical velocity.

(8) Maximum flooding level exists.

(9) When the paint detaches, the particles align themselves one next to the other on the SIS Sump screens.

Additionally, the following observations were made:

(10) Ductwork above the SIS Sump screen at El. + 6.0' blocks the falling paint from falling onto the pool surface.

(11) I-beams, below the pool surface supporting the grating at El. -4.0' collect the paint falling on the water surface above the beam and this prevents these chips from reaching the screen.

Methodology

The methodology used in analyzing this problem is the following:

(1) The settling (vertical) velocity of the paint fragment is determined.

(2) The average drift velocity of the water in the pool (moving towards the SIS Sump screens) is determined.

(3) Using (1) and the SIS Sump depth, the time for the paint to reach the bottom of the SIS Sump screen (El. -11.0') is determined.

(4) Using (2) and (3) the maximum and minimum distance from the SIS Sump screen for which paint can hit the screen are determined.

(5) The amount of paint that falls into the area on the pool surface from which it can then hit the screen is determined.

(6) The amount of screen area blocked is determined.

(7) Geometrical considerations that may shield some of the screen from being blocked are accounted for.

(8) A determination is made as to whether the area of the screen left unblocked is sufficient for proper pump operation.

Two-Dimensional Analysis

This analysis assumed that the paint fragment is a disk which hits the pool surface at any incident angle. Conservatively, small paint fragments are assumed to be momentarily arrested at the water surface, then to start their travel through the water at the angle of impact with zero initial velocity. Any angle of impact is equally probable since tumbling motion would be expected. However, as shown in Reference 1, the final paint vertical velocity is a minimum (which is conservative) for an incident angle (θ) of 0°. Referring to Figure 2, the equation describing the vertical motion of the paint through the water when the pitch angle is assumed constant is the following:

$$\rho_p \; V_p \; \frac{du}{dt} = \rho_p \, V_p \; g - \rho_w \, V_p \, g \; - \frac{C_D}{2} (\phi) \; \rho_w \, A_{proj} \sin \beta \, W^2$$

$$- \frac{C_L}{2} (\phi) \quad \rho_w \, A_{proj} \cos \beta \, W^2 \qquad (3)$$

where: $W^2 = u^2 + (V_o - v)^2$

$$A_{proj} = \frac{\pi d}{4}^2 \sin (\phi)$$

and: u = vertical component of the fragment velocity, defined as positive downward

- v = horizontal component of the fragment velocity
- ρ_p = paint density
- ρ_w = water density
- W = fragment relative velocity
- V_o = velocity of pool toward the screen
- C_D = drag coefficient
- C_L = lift coefficient
- β = angle from pool surface to the velocity vector
- V_p = fragment volume
- t = thickness
- g = acceleration of gravity

Since a steady-state velocity is quickly reached and assuming $\beta = 90^o$, Equation 3 reduces to:

$$0 = \rho_p V_p g - \rho_w V_p g - \frac{C_D}{2} (\phi) \rho_w A_{proj} W^2 \quad (4)$$

Conservatively assuming that $v = V_o$, $\phi = 90°$ and $\theta = 0°$ and using the conservative maximum $C_D = 1.9$ from Reference 1, Equation 4 reduces to:

$$0 = \rho_p \left(\frac{\pi d^2}{4}\right) tg - \rho_w \left(\frac{\pi d^2}{4}\right) tg - \frac{C_D}{2} \rho_w \frac{\pi d^2}{4} W^2 \quad (5)$$

$$\text{or} \quad (\rho_p - \rho_w) g = \frac{C_D}{2t} \rho_w u^2 \quad (6)$$

Using conservative values of $\rho_p = 82.3$ lbm/ft^3, $\rho_w = 60$ lbm/ft^3, $t = 5$ mils and $C_D = 1.9$ we have:

$u = .072$ ft/sec

Knowing the maximum pool height it can be calculated that the time to reach the SIS Sump screen bottom is 159.3 seconds.

FSAR Section 6.2.2.2.2.1 (Reference 2) states that the water velocity at the screen is 0.13 ft/sec. Accounting for the open area of the screen and the pool depth, the drift velocity in the pool towards the screen is 0.0227 ft/sec. The maximum horizontal distance travelled by the paint is then 3.62 ft. From geometry, as shown on Figure 3, the minimum distance at the pool surface horizontally from the screen from which paint can reach the screen is 2.04 ft. However, a series of Trisodium Phosphate Dodecahydrate (TSP) baskets surrounding the screens interfere with some of the falling paint. As a result of blocking by the baskets, the maximum distance from which paint can hit the screens is reduced to 3.42 ft. Although the baskets would block paint from reaching the bottom of the screens, gravity would bring down excess paint from the top of the screens to block the bottom also. Of all of the paint that is assumed to detach, a percentage of it (approximately 0.05 percent) would fall into a near field critical area on the pool surface from which it could reach the screen. This area surrounds the SIS Sump screens between a distance of 2.04 ft and 3.42 ft. However, a significant portion of this area above the screens is blocked by I-beams and ductwork. The actual situation is shown in Figure 4.

There are I-beams supporting the grating at El. - 4.0' which, in effect, will produce a shadow on the screens by blocking the paint that falls on them. Additionally, there is ductwork at El. +6.0' that shields part of the pool. The net effect of the shielding of the SIS Sump screens by the I-beams and ductwork is that approximately 34-1/2 percent of the vertical screens remain open.

Reference 3 (which required that only 10 percent of the vertical screens remain open)shows that this amount of open area is more than sufficient to prevent vortexing at the pump intakes and also allows for sufficient Net Positive Suction Head (NPSH) to ensure proper pump operation.

Three-Dimensional Analysis

In order to confirm the assumptions of the above calculation, a detailed three-dimensional analysis of the fluid flow around the SIS Sump screens

was performed. The computer program TEMPEST (Reference 7) was utilized to calculate the velocities in the SIS Sump vicinity. This computer code solves the full three-dimensional equations of motion, continuity and heat transport for laminar or turbulent fluid flow using the finite-difference techniques. Turbulence is treated using a two-equation $k-\epsilon$ model.

In the Two-Dimensional Analysis, the horizontal (drift) velocity was assumed directed toward the SIS Sump on the four sides of the screen. However, in the Three-Dimensional Analysis, the geometry of the SIS Sump, the location of the openings and the presence of the baskets give a more accurate flow field. Figures 5 and 6 show horizontal cross sections at Elevations -10.5' and -3.0' respectively and Figure 7 shows a vertical cross section for the case of unblocked screens. The results show that most of the flow comes from the right side because of the size of the opening and the presence of only two baskets. Figure 6 shows that the flow on the left and top left is away from the screen, thus confirming that the screen on the left side remains unclogged even without taking credit for the presence of the duct on top. Also, the proximity of the baskets to the screen and their height (60 percent of the screen) gives more unblocked screen area due to the shading effect. Based on the above and the velocity profiles developed in the Three-Dimensional Analysis (which in some cases shows flows parallel to, or away from the screens), the 34-1/2 percent open area of the vertical SIS sump screens as developed by the Two-Dimensional Analysis is conservative.

In addition, an analysis was performed that postulated that except for the vertical screen under the duct all other screens (vertical and horizontal) are blocked. The results shown in Figures 8 and 9 indicate that no additional paint fragments (from the near field or the far field) can be swept up to block the open screen.

VIII. EVALUATION OF SECONDARY EFFECTS OF COATING FAILURE ON NSSS EQUIPMENT

As secondary effects, coating failure was also evaluated for small paint chips passing through the SIS Sump screen. In this case fine particles (less than 0.078 in) enter the SIS and also the Reactor Coolant System (RCS). The effects of this type of coating failure on NSSS are summarized below.

Source Term

The maximum quantity of paint which could reach the SIS Sump, calculated from the Two-Dimensional Analysis (Section VII), is approximately 115 lbs (1.39 ft^3). To evaluate the potential adverse effects of this material on post-accident fluid systems, it must be assumed that this paint takes the form of fine particulate matter which mixes homogeneously with the recirculating coolant. The design of the SIS Sump screens ensures that particulate matter greater than 0.078 inches in size cannot be ingested into the SIS or the RCS.

Identification of Concerns

Two conditions of concern have been postulated with this particulate matter suspended in recirculating coolant: (a) detrimental effect on the HPSI, LPSI, and CSS pumps or restriction of flow through the reactor core, or (b) consequence of the paint fines settling in the fluid systems.

HPSI Pumps

The HPSI pumps are used in the recirculation mode following any LOCA. The pump vendor has confirmed that particulate matter 0.090 inches in diameter will have no detrimental effect on operation of the HPSI pumps.

LPSI Pumps

The LPSI pumps are not required during recirculation. However, for small breaks, it is possible that they would be used for shutdown cooling.

The LPSI pumps are used in this mode. The pump vendor has confirmed that particulate matter 0.250 inches in diameter will have no detrimental effect on operation of the LPSI pumps.

Reactor Core

In the reactor core, the location of the smallest flow area (the potentially limiting flow area) occurs at the fuel spacer grid-fuel rod intersections. FSAR Section 4.2.2.1, FSAR Table 4.2-1, and FSAR Figures 4.2-8 and 4.2-9 (Reference 2) depict the configuration and dimensions of the fuel spacer grids. By design, particulate matter up to 0.090 inches in size will not become lodged in this area. It should be noted that avoidance of the potential for flow blockage in the reactor core was the principal design basis considered in the sizing of the SIS Sump screen.

The distance between fuel spacer grids on a fuel assembly is approximately 15 inches. Therefore, even given the unrealistic assumption that at the spacer grid-fuel rod intersection paint coating blockage did occur, there would be cross flow in the regions of the fuel assembly where there is no fuel spacer grids, and therefore there would be adequate cooling of the core.

Finally, an experimental and analytical program, described in FSAR Section 4.2.3.2.16 (Reference 2), was conducted to determine the effects of fuel assembly coolant flow maldistribution during normal reactor operation. The program and results included the following:

a) The assembly inlet flow maldistribution caused by blockage of a core support plate flow hole. Evaluation of the flow recovery data indicated that even the complete blockage of a core support plate flow hole would not produce a Waterford-3, Burnout Heat Flux Correlation, DNBR of less than 1.0 even though the reactor might be operating at a power sufficient to produce a DNBR of 1.3 without the blockage.

b) The flow maldistribution within the assembly caused by complete blockage of one to nine channels was also evaluated. Flow distributions were measured at positions upstream and downstream of a blockage of one to nine channels. The influence of the blockage diminished very rapidly in the upstream direction. Analysis of the data for a single channel blockage indicated that such a blockage would not produce a Waterford-3 DNBR of less than 1.0 downstream of the blockage even though the reactor might be operating at a power sufficient to produce a DNBR of 1.3 without the blockage.

The experimental and analytical program demonstrated that, even at normal power conditions, the influence of blockage in the core diminishes very rapidly.

IX. EVALUATION OF SECONDARY EFFECTS OF COATING FAILURE ON BOP EQUIPMENT

For the purpose of this portion of the analysis it is assumed that paint particles, of sizes less than 0.078 inches pass through the screen and enter the SIS and CSS. The following is an evaluation of the impact of this paint intrusion on components of these systems.

Following a LOCA or MSLB, fluid escaping from the primary or secondary system break or discharged by the CSS, will accumulate in the SIS Sump and the lower level of the Containment. This water will contain any failed paint that would be removed from its original location by either the environmental conditions present within the RCB and/or the impingement of fluid. The recirculation mode would transport paint particles that pass through the screens to the HPSI and CSS pumps for reinjection into the RCS and Containment, respectively. To ensure a complete evaluation, the LPSI pumps and SDCS have been included since their operation is conceivable during long-term post-LOCA operations.

There are various types of equipment that are utilized in these systems. They are:

- valves (gate, globe, check, butterfly and stop-check)

- pumps (vertical and horizontal centrifugal)

- heat exchangers

- miscellaneous (orifices/flow elements, spray nozzles, vortex breakers and instrumentation).

Each of the above items have been evaluated for detrimental effects caused by the transported paint. The paint particles are not expected to present any erosion problems for any of the material in the equipment identified above (for erosion to take place it is necessary to have high flow velocity and some concentration of very hard abrasive particles in the flow, - none of these conditions are present in the system following LOCA).

Concerning the potential of blockage due to an accumulation of paint, it is expected that particle settling will occur only in areas of low velocity. Based on this, flow blockage is not expected to occur in the individual pipelines or within any of the valves or pumps. The flow velocity within the tubes of the Shutdown Heat Exchanger is sufficiently high to avoid plugging. Paint particles could accumulate in the low velocity section of the heat exchanger's channel heads. However, this would not be detrimental as the buildup would not exceed the height of the tube openings on the tube sheet. Once the paint buildup approached this height, it would leave the low velocity region and thus be exposed to higher flow velocity.

The Containment Spray Nozzle is not susceptible to blockage since the nozzle throat diameter is much greater than the paint particle (i.e., 0.375" is much greater than 0.078"). The vortex breaker is composed of grating plates of similar size to the sump trash rack. Each opening is approximately 1/2" x 1-1/4" and would not be susceptible to blockage. Instrumentation taps are taken from the sides or top of the piping. Therefore, particle settling would not occur. Also, since the fluid in these lines is stagnant, particle transportation required for blockage conditions in the lines, would not occur. All orifices and flow elements are provided with bore sizes that greatly exceed the particle size that can pass through the screens.

Another potential detrimental effect that can be attributed to failed coating is the loss of heat transfer through the Shutdown Heat Exchanger. In the initial phases of an accident heat from the Containment is removed by cooling the SIS Sump water before it is redischarged via the CSS. Cooling is accomplished at the Shutdown Heat Exchanger where heat from the SIS Sump water is transferred to the Component Cooling Water System via the tube material. Any fouling of the tubes would reduce the performance of the heat exchanger. Since the paint is not expected to decompose and the flow through the tubes is relatively high, no significant particulate fouling is expected.

Also considered was the potential for a loss of equipment performance due to paint particle transport. This would include loss of function and equipment damage. All valves have been reviewed to determine if an accumulation of paint could impair valve operation. The only valve type that could be affected is the gate valve. This valve has an area, known as the crotch, which could be susceptible to sediment accumulation. The crotch is located directly opposite the stem and accepts the outer portion of the disc as the valve is closed. If this area were significantly blocked, the disc could be prevented from fully seating and result in a partially open valve. This event could only occur if valve was open for an extended duration and then be required to close. A review of the affected systems has shown that there are no gate valves, that are required to close after being open.

All pumps have been examined for possible detrimental effects due to paint transportation. The Containment Spray Pumps were designed to pass particles of up to 1/4 inch in diameter. Each pump is provided with oil lubricated bearings. The mechanical seal water supply line is provided with an abrasive separator to remove particulates from the seal water. If a failure of the separator is assumed, the seal would either be exposed to abrasive fluid or a loss of sealing fluid. However, considering the design and construction of the seals, complete pump degradation or failure is unlikely.

X. NPSH AVAILABLE TO HPSI AND CS PUMPS

NPSH evaluations assuming the clogging of SIS Sump screens have been previously performed, and the results of these evaluations have demonstrated that adequate NPSH is available to ensure proper operation of the HPSI and CS pumps. These evaluations are documented in the responses to NRC Questions 211.64 and 211.10 (Reference 2) and FSAR Sections 6.2.2.3.2.1 and 6.3.2.2.2.3. (Reference 2). A basis for the NPSH information documented in the foregoing questions and sections is a full-scale hydraulic model test that was performed by Western Canada Hydraulic Laboratories (WCHL).

The test conducted by WCHL was a 1:1 scale model of the Waterford 3 SIS Sump, intakes, screen cage, and all containment geometry significantly affecting the approach flow conditions. The head lost tests were conducted with the top screen completely blocked and with 50 percent of the vertical screens blocked.

Based on the WCHL tests the maximum screen loss was found to be 0.098 ft. at 11,780 GPM flow and 50 percent screen blockage. For post LOCA recirculation mode, only the operation of the CS pump and the HPSI pump is required with the combined flow rate of 3140 GPM capacity. This flow is substantially less than the 11,780 GPM flow used to determine the maximum screen loss. Since the head loss through the screen is proportional to velocity head, measured screen loss can be extrapolated to 3140 GPM flow and 90 percent blocked screen, by the calculation shown here:

$$\text{Screen loss} = \frac{(3,140)^2}{(11,780)^2} \times (0.098) \times \frac{(.9)^2}{(.5)^2} = 0.0225 \text{ ft.}$$

Thus, 0.0225 ft. is the screen loss at 90 percent blocked screen and 3140 GPM flow (the screen loss with 11,780 GPM flow and 90 percent screen blockage is 0.317 ft.).

The NPSH required and NPSH available are shown here, see FSAR Sections 6.2.2.3.2.1 and 6.3.2.2.2.3 (Reference 2), for the CS and the HPSI pumps:

Pump	Flow (GPM)	NPSH (Available)	NPSH Required	Percent Margin
CS	2250	27.27	14	94.8
HPSI	890	25.35	18	40.8

The NPSH margins available for the CS and HPSI pumps are 94.8 percent and 40.8 percent. Thus, the calculated screen loss of 0.0225 ft. represents an insignificant 0.2 percent of the NPSH available for the CS pump and even less for the HPSI pump. Therefore, 90 percent blockage of the SIS Sump screen has a minimal effect on pump NPSH.

XI. INSULATION INSIDE CONTAINMENT

Type and Description

There are four types of insulation used inside the Containment. They are:

1. Metal Reflective,

2. Metal Encapsulated,

3. Fiberglass Insulation Encapsulated with glass cloth, and

4. Radiant Energy Shield (fire wrap).

The metal reflective insulation is built of stainless steel panels. The panels consist of interior and exterior sheets. The exterior sheets are 24 gage austenitic steel, type 304. The interior material is three layers per inch of 0.002 inch thick waffled, type 304, stainless steel sheets. This insulation is manufactured by Transco. This insulation is attached, to the surface to be insulated, using either of two methods. One method is buckle fasteners (positive lock-quick release buckle fasteners). The other method is by using stainless steel, #14, self-tapping screws. It is estimated that the total area of metal reflective insulation is approximately 3,500 square feet. This insulation is used on the Reactor Vessel, Reactor Head and Reactor Coolant Pumps.

The second type of insulation is metal encapsulated. This insulation consists of Owens-Corning inner material and Transco's encapsulating material. Owens-Corning identifies this insulation as TIW Type II, FG (fiberglass) encapsulated. This material conforms to the property requirements of government specifications: HH-1-558B (Amendment 3), Form B-Blanket and Felt, Flexible, Type I Blankets, Flexible, Class 7 and 8; MIL-1-24244 Chemical Requirements and USCG 164.009/135/2. Transco provides the encapsulation material for the fiberglass insulation. The fiberglass is totally encapsulated. The method of attachment is buckle

fasteners (positive lock-quick release buckle fasteners). The construction of the totally encapsulated modules is exactly the same as for the reflective-type, except that non-reflective insulation (fiberglass) is used inside. It is estimated that approximately 7,400 linear feet of insulation is supplied for piping while another 15,000 square feet of insulation is supplied for equipment. This insulation is applied to the Steam Generators, Pressurizer and skirt, Regenerative Heat Exchanger and Quench Tank in addition to various piping systems.

The third type of insulation is a fiberglass insulation fully encapsulated with glass cloth. The fiberglass cloth material is referred to as a Temp Mat insulation as manufactured by Alpha Company. This "donut" or "flexible collar" insulation is tied around the 91 CEDM nozzles and 10 instrumentation nozzles. The collars are held together using two (2) levels of stainless steel wire. It is estimated that approximately 155 linear feet of this type of insulation is used inside Containment.

The last type of insulation is the radiant energy shield. This shield is a fire resistant ceramic fiber blanket fully encapsulated within a high silica content fabric mesh. Final assembly includes an interior liner of fiberglass mat. The encapsulation is accomplished by joining outer layers with a quartz thread and a reinforced nylon thread. The radiant energy shield is formed by wrapping the assembly about conduit or electrical cable trays by the use of galvanized metal frames and is attached with galvanized threaded bolts and screws. It is estimated that approximately 200 linear feet of radiant energy shield is used inside Containment.

Debris Generation

All four types of insulation are designed to remain intact when exposed to Containment Spray, the only mechanism that would dislodge the insulation is jet impingement from a pipe break.

All metal materials from the insulation will sink. In addition, the smallest metal part (rivet) has a diameter of 1/8 inch, this is larger than the fine screens (0.078 in).

Although the fiberglass and ceramic mats may be lighter than water, the individual fibers have a specific gravity of at least 2.0 and thus would sink. In addition, individual fiberglass and ceramic filaments are approximately 5 mils in diameter. Therefore, although individual fibers could pass through the SIS Sump screens they would have no effect on SIS or CSS equipment.

Jet Impingement

A review of the jet impingement drawings was conducted. None of the Jets' destruction areas (7L/D criteria of NUREG-0897, Rev. 1 Draft) are within the near field of the SIS Sump. Therefore, the results of the subject report remain valid considering the 7L/D criterion.

FSAR Figures 1.2-17 through 1.2-22 (Reference 2) provide General Arrangement Plans and Sections of the Reactor Building. As depicted by these figures, the RCS is surrounded with reinforced concrete. Also, the Main Steam Lines are more than 50 ft. horizontally and 50 ft. vertically from the SIS Sump, and there are intervening structures.

FSAR Figures 1.2-18 and 1.2-20 (Reference 2) show blowout areas by each Reactor Coolant Pump. However, the closest break is more than 15 ft. vertically and more than 35 ft. horizontally (around corners) from the SIS Sump.

Conclusion

Although a pipe break with its resulting jet impingement cone could dislodge insulation, the insulation would sink and thus could not block the SIS Sump. In addition, no jet impingement cone would generate insulation debris near the SIS Sump. Therefore, there is no potential for SIS Sump blockage due to insulation debris.

XII. IMPACT OF PAINT ON TSP BASKETS

Postulated paint blockage of the TSP baskets is not expected to have any adverse effect since the TSP is expected to be substantially dissolved prior to the recirculation mode.

TSP is used as a pH control agent for water circulated within containment following a LOCA. Borated water from containment spray and safety injection tanks characteristically exhibit a pH below 5. TSP is utilized to raise and stabilize the pH to approximately 7 to reduce the possibility of chloride stress corrosion cracking. FSAR Figure 6.1-1 (Reference 2) shows the length of time necessary to reach a pH of 7 is between 2-3 hours depending on the boron concentration in the containment spray. The FSAR data was conservatively calculated using a water temperature of 120°F in the SIS Sump.

Combustion Engineering has measured the dissolution rate of TSP in water under conditions much more conservative than would be encountered during Containment Spray System operation. TSP granules were compressed under a pressure of 20,000 psi into cylindrical pellets having dimensions of 0.53 inches in diameter by 0.78 inches in length and having a bulk density of 1.65 gm/cm^3, which is higher than the density of the crystalline TSP. This form of TSP has a lower surface area to volume ratio and lower solubility than the bulk chemical, so it represents a conservative form for testing the rate of dissolution. In stagnant water at 85°F, the pellets dissolved in 375 seconds. At 200°F, dissolution time was reduced to 250 seconds. The report concludes that dissolution rate of TSP increases with temperature, and for granular TSP, the rate is almost instantaneous.

FSAR Section 6.1.3 (Reference 2) indicates that the CS water will dissolve the TSP within 3 hours following CSAS, with approximately one-fourth dissolved during the injection mode. Even if the top and outward faces of the TSP baskets were to be completely covered with coating particles and flowthrough action were inhibited, it is evident from the solubility data that so long as the TSP is in contact with

water, even in completely stagnant water, it will dissolve, and within a short period of time.

Further, chloride stress corrosion cracking is a long-term effect. Even if partial blockage of the TSP baskets caused an increase in the time required to reach a pH of 7, the relative times involved would not decrease the effectiveness of the pH control system.

XIII. TESTING AND SURVEILLANCE

Surveillance and testing measures have already been implemented by LP&L.

As stated in Section III, the containment coatings are substantially qualified. Previously identified coating deficiencies have been evaluated, and corrective measures have been taken, including a thorough inspection of coating systems and repair of all deficient areas in accordance with approved specifications and procedures pursuant to ANSI N101.2, N5.12, and N101.4.

Also, as stated in Section III, an in situ test of the containment coating was conducted by Ebasco. The testing simulated DBA conditions in the containment and applied borated water, simulating the containment spray solution. The testing demonstrated the integrity of the coating system.

REFERENCES

1. Report by Gibbs & Hill, Inc. for Texas Utilities Generating Company, Comanche Peak Steam Electric Station "Evaluation and Insulation Debris Effects on Containment Emergency Sump Performance," Revision 1, October 1984.

2. Waterford SES Unit No. 3 Final Safety Analysis Report, Docket No. 50-382.

3. Report by Western Canada Hydraulic Laboratories, LTD for Ebasco Services, Inc., Louisiana Power & Light Company, Waterford Unit No. 3 "Model Testing of the Safety Injection Sump," June 1982. (Submitted to NRC via LP&L Letter W3P82-1755, dated June 28, 1982).

4. NUREG/CR-2791, "Methodology for Evaluation of Insulation Debris Effects," September 1982.

5. LP&L Letter W3P85-0130, dated January 17, 1985.

6. LP&L Letter W3P85-0449, dated February 27, 1985.

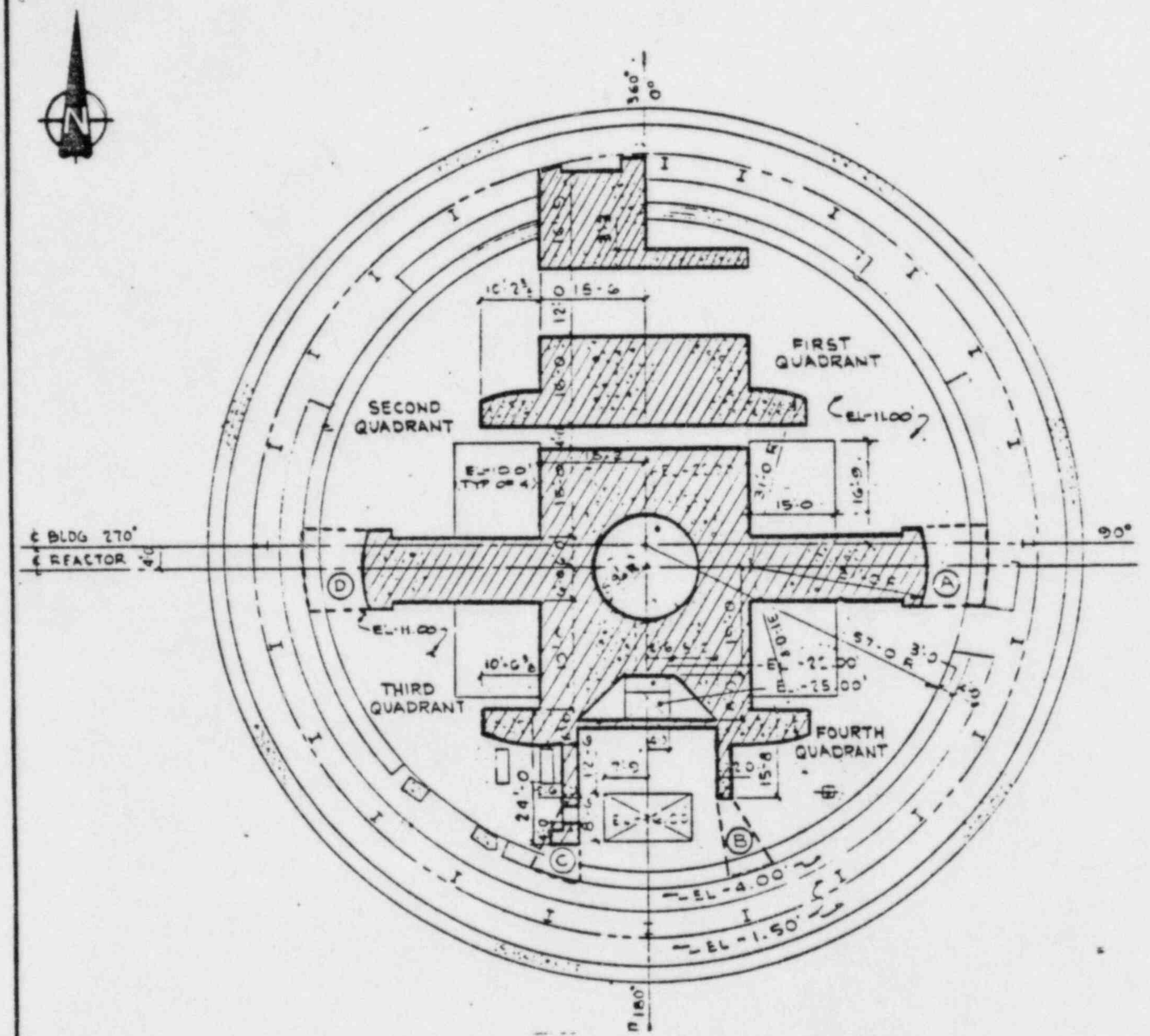
7. "TEMPEST. A Three-Dimensional Time-Dependent Computer Program for Hydrothermal Analysis," Battelle, PNL-4348 Vol. 1, September 1983.

TABLE 1

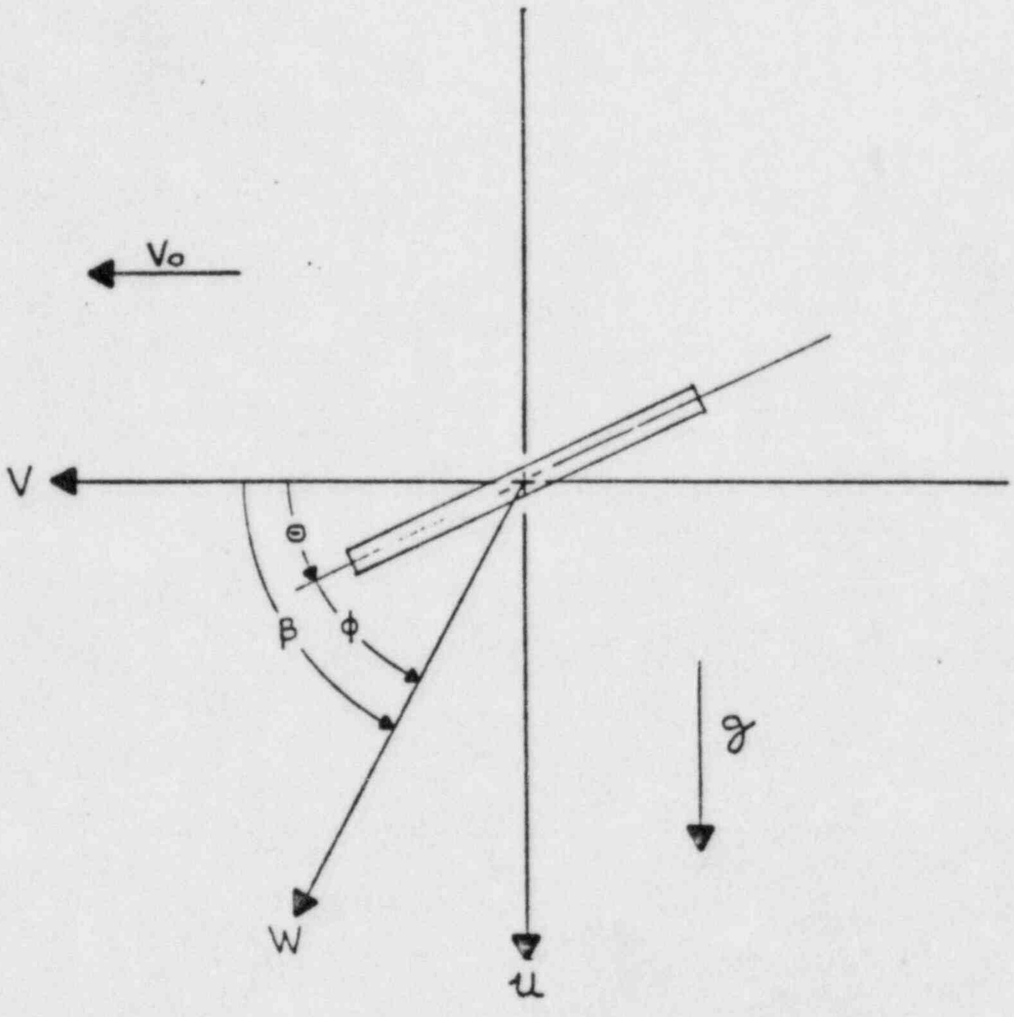
CONTAINMENT COATING MATERIALS ASSUMED TO FAIL

Coated Surface	Primer and Topcoat*	Thickness (mils)	Dry Density (lbm/gal)	Approximate Area (sq ft)
Carbon steel exposed to primary containment atmosphere-uninsulated piping, structural main equipment	Dimetcote E-Z	2-7	16.0	275,825
	Dimetcote 6	2-7	16.0	
	Amercoat 71	2-18	11.0	
	Amercoat 90	5-11	11.0	
Containment vessel dome	Carbozinc 11	2-5	21.3	30,788
	Phenoline 305	5-7	11.0	
Miscellaneous touch up on galvanized steel	ZRC cold galvanizing compound	3-4	17.8	8,000

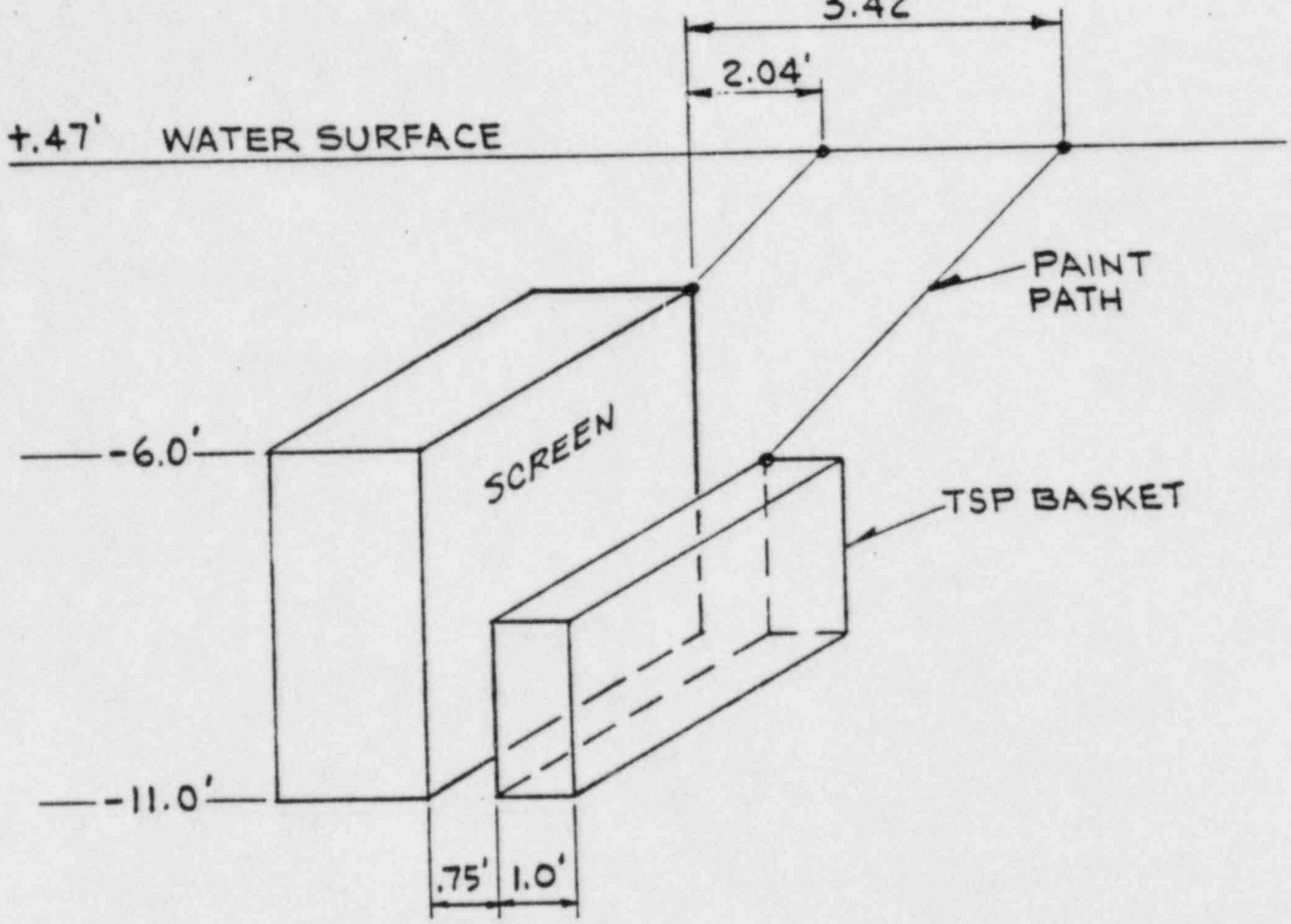
* Dimetcote E-Z, Dimetcote 6, Amercoat 71, and Carbozinc 11 are Primers; Amercoat 90 and Phenoline 305 are Topcoats. Only one primer was used on any surface in preparing a surface for the application of a topcoat.



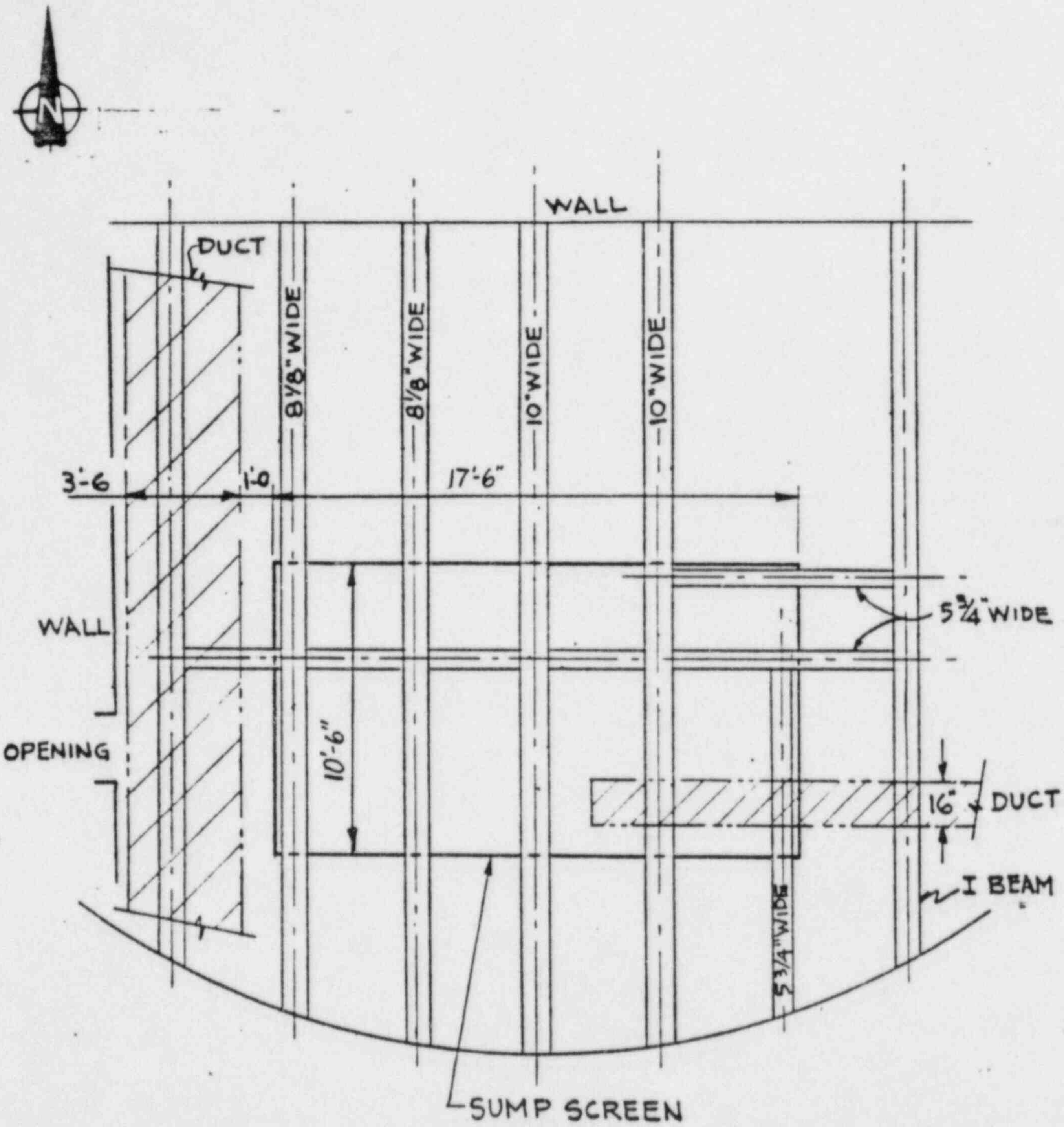
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	SIS SUMP FAR FIELD EFFECTS	Figure 1



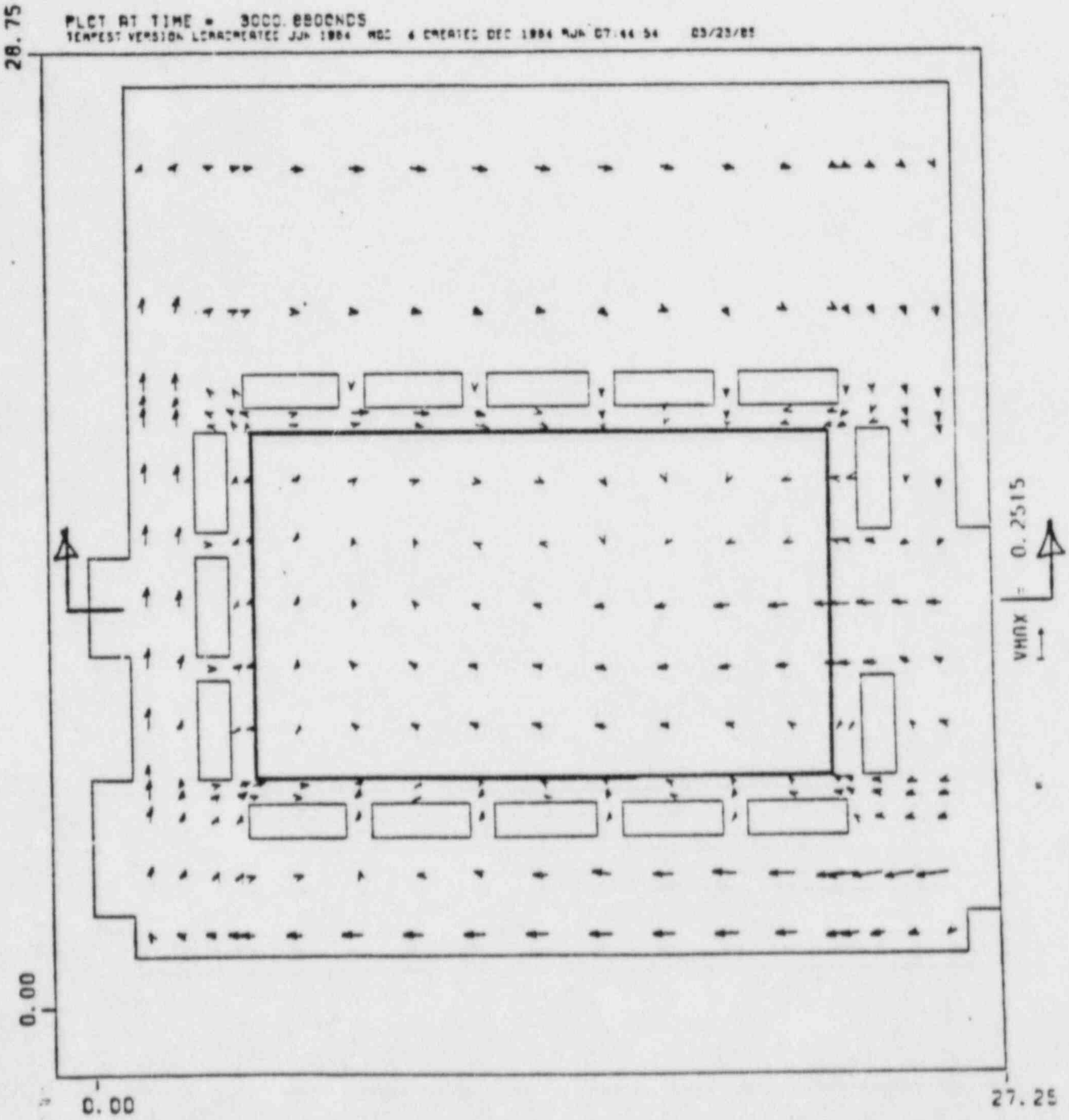
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	SIS SUMP CHIP MOTION WITH CONSTANT ANGLE	Figure 2



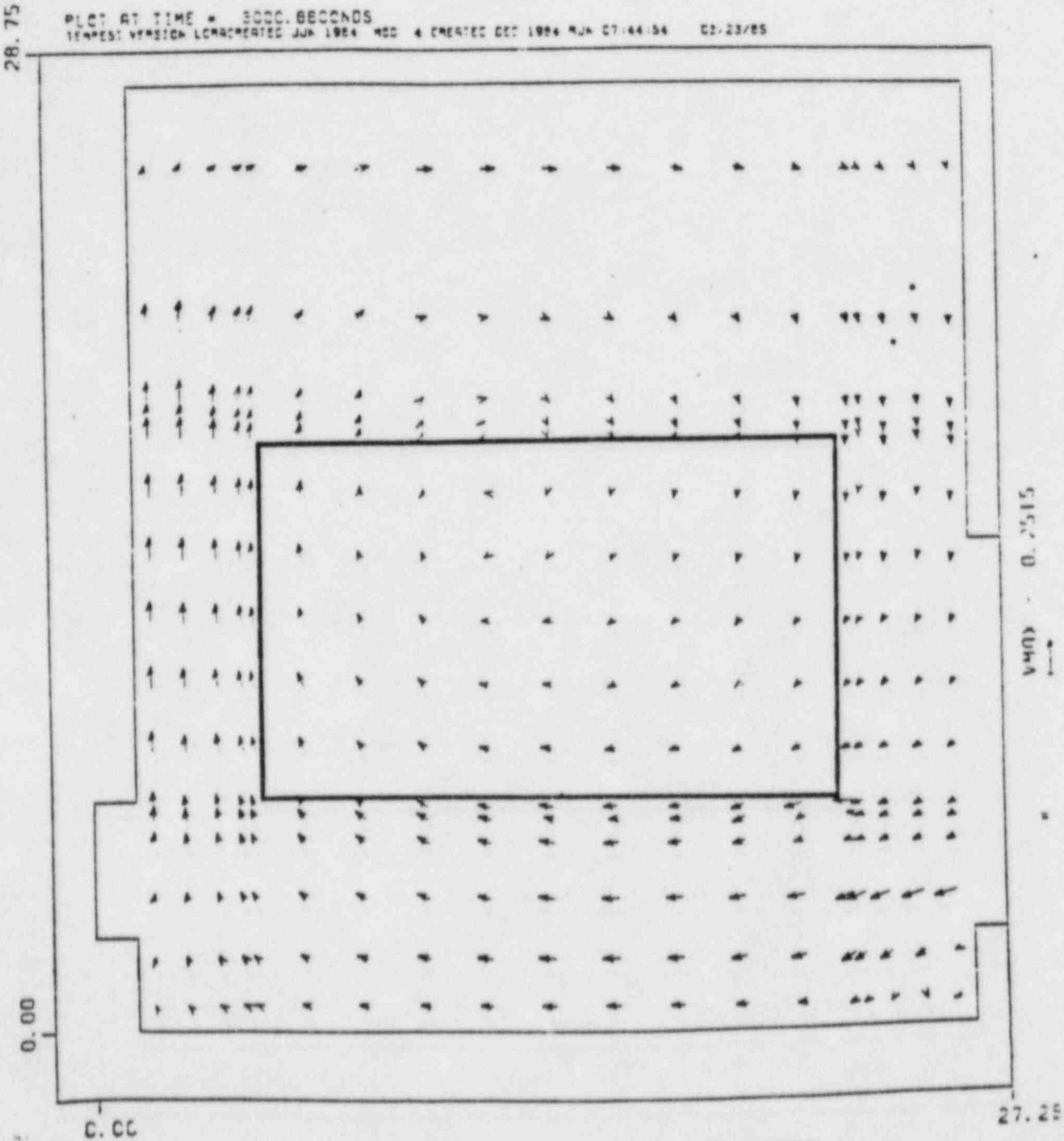
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	SIS SUMP NEAR FIELD EFFECTS	Figure 3



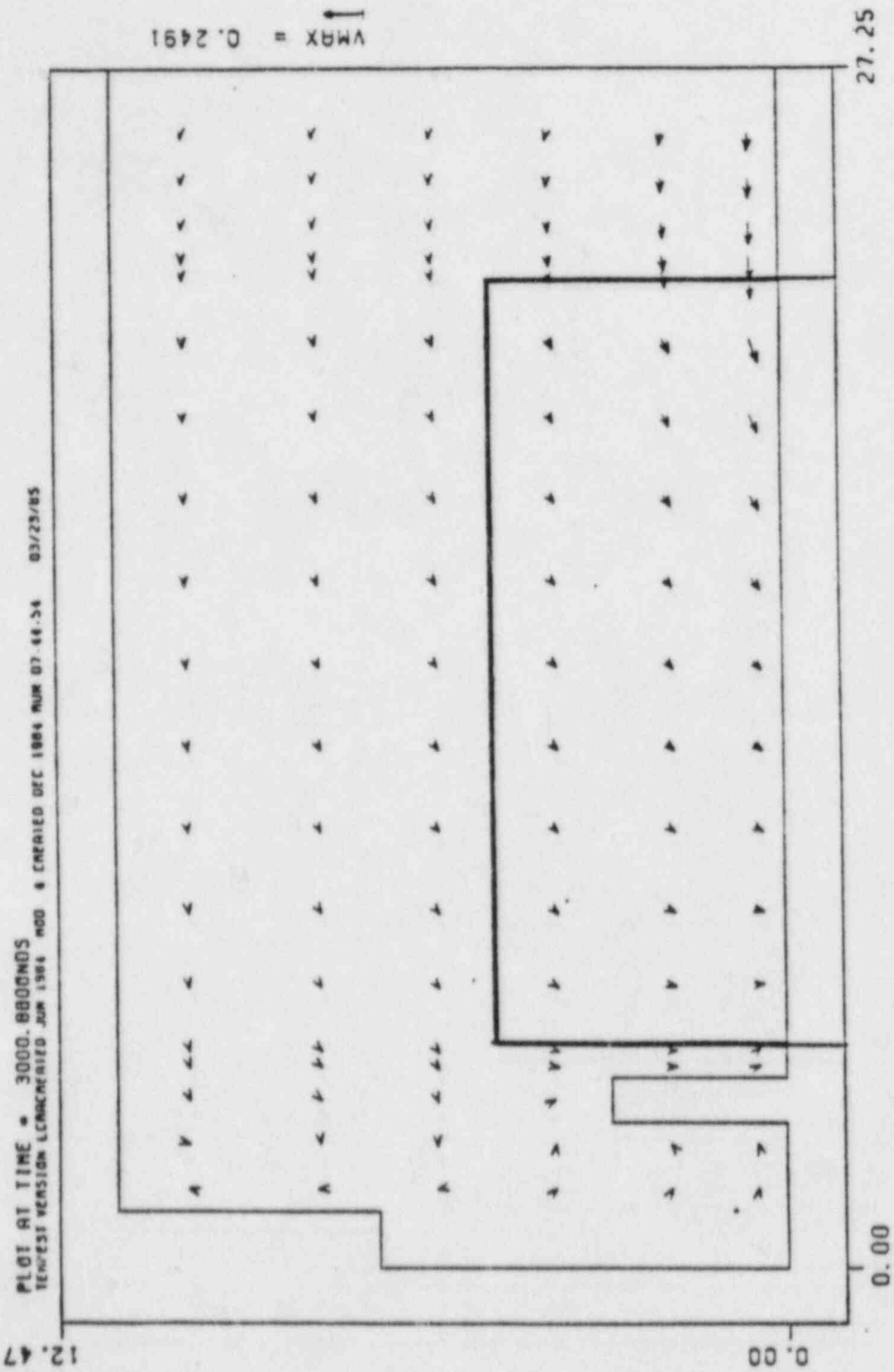
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	SIS SUMP PLAN VIEW	Figure 4



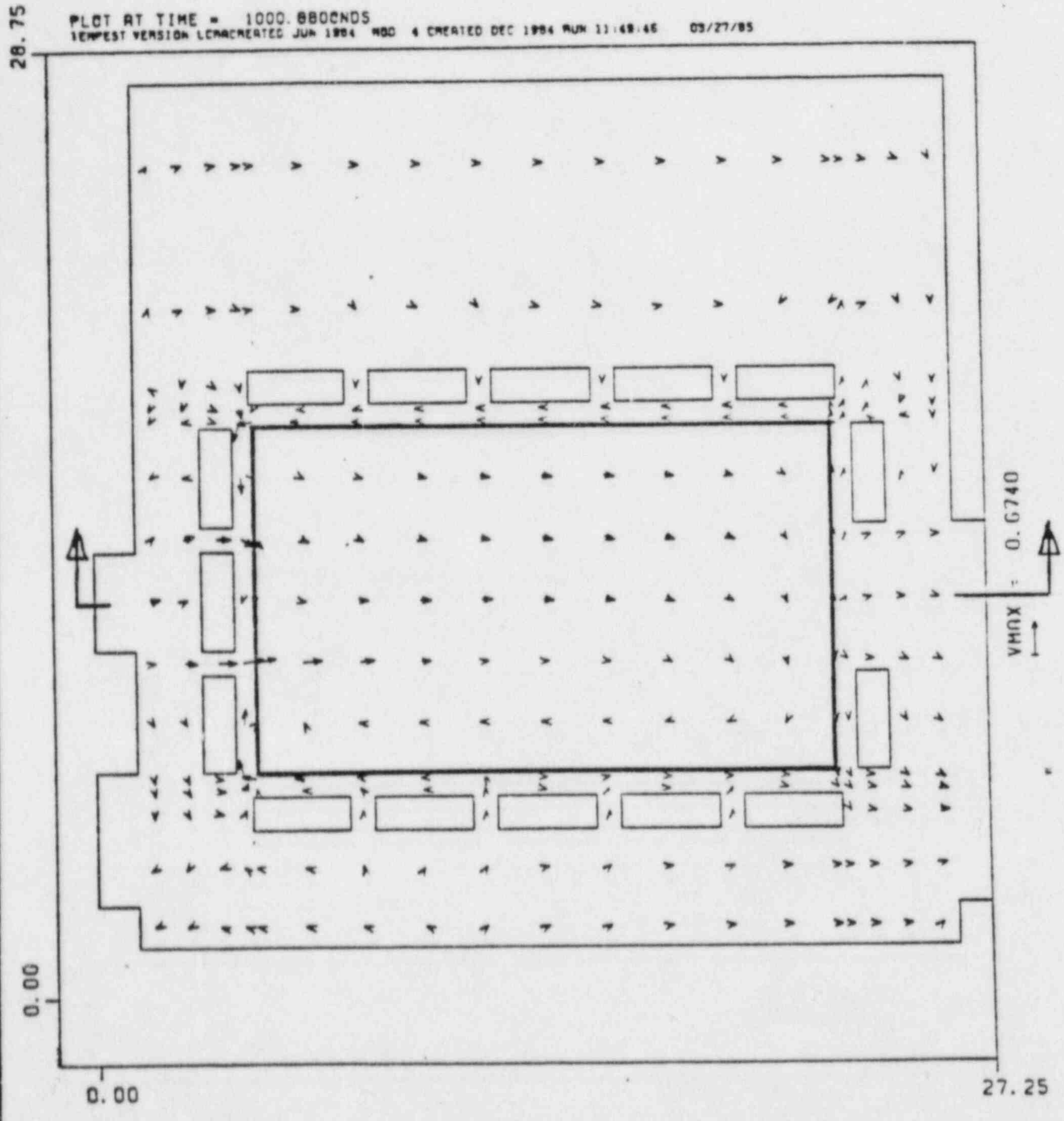
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	3-D ANALYSIS UNBLOCKED SIS SUMP SCREENS – HORIZONTAL ELEVATION – 10.5'	Figure 5



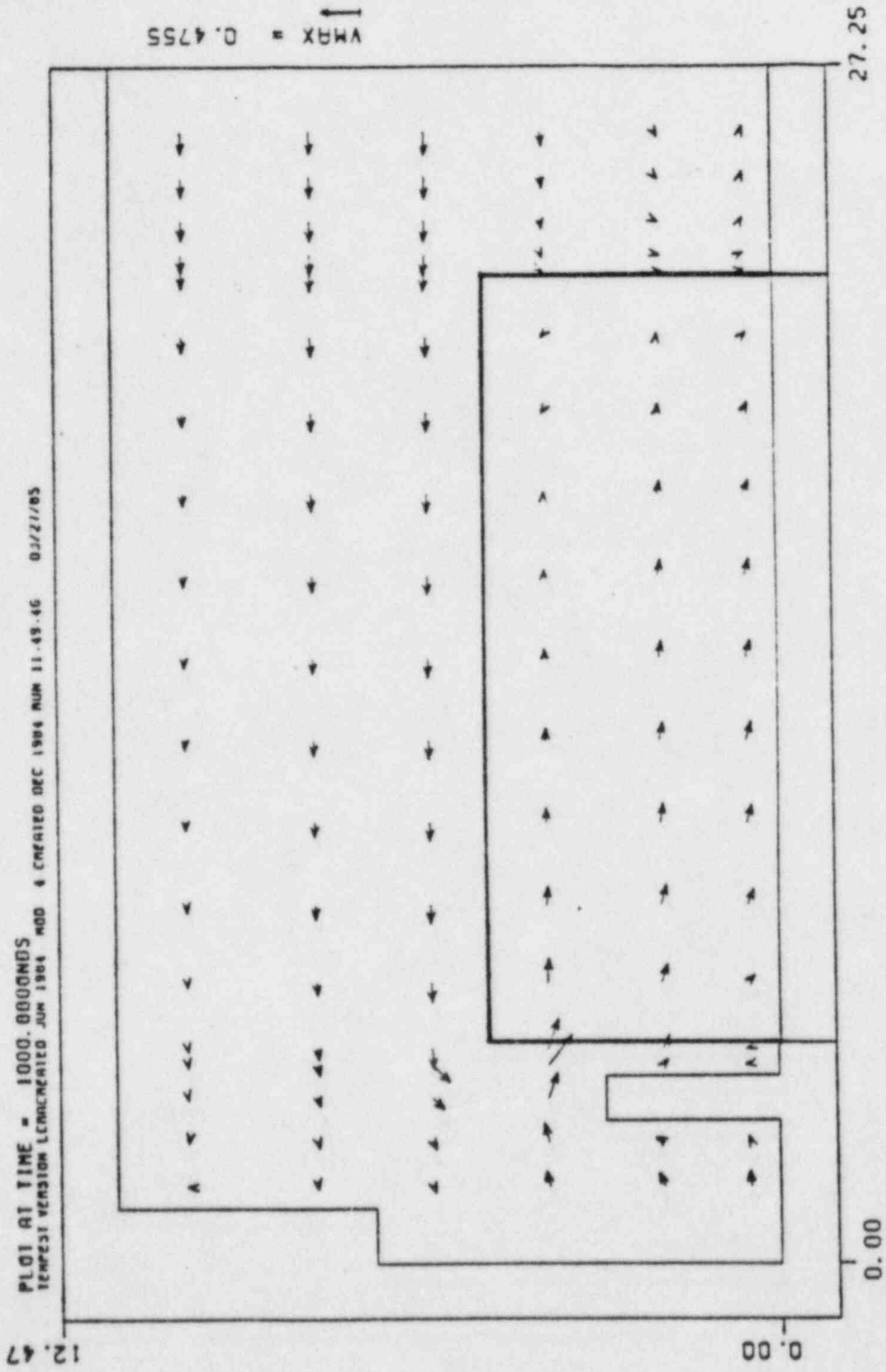
LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	3-D ANALYSIS UNBLOCKED SIS SUMP SCREENS – HORIZONTAL ELEVATION – 3.0'	Figure 6



LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	3-D ANALYSIS UNBLOCKED SIS SUMP SCREENS– VERTICAL	Figure 7



LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	3-D ANALYSIS BLOCKED SIS SUMP SCREENS – HORIZONTAL ELEVATION – 10.5′	Figure 8



LOUISIANA POWER & LIGHT CO. Waterford Steam Electric Station	3-D ANALYSIS BLOCKED SIS SUMP SCREENS – VERTICAL	Figure 9

ATTACHMENT 1

SAMPLE TEST REPORTS - CARBOLINE COMPANY

LABORATORY TEST REPORT

October 1, 1973/Page 1

TESTING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

SUBJECT: Evaluation of the Carboline and AB Alfort & Cronholm water-based epoxy surfacers for application in Nuclear Primary Containment, employing the ANSI N101.2-1972 PWR Containment, BWR Dry Well and BWR Suppression Chamber Composit Curve.

REFERENCE: Swedish Government Agency, Mr. Lars Thureson; Mr. H. D. Tarlas; ANSI N101.2-1972.

PURPOSE: Comparison of the performance of the Alcro Betongspackel and Carboline X2191-158 water-based epoxy surfacers, each being topcoated with Standard Phenoline 305 and developmental water-based epoxy finishes, after exposure to the time-temperature curve specified in the referenced test exposure and evaluated according to ANSI N101.2-1972, Section 4.5.

CONCLUSION: After completion of this 11-day, 2-3/4 hour test exposure, it can be concluded that:

1. The Carboline X2191-158 water-based epoxy surfacer has an excellent performance when topcoated.

2. The Alcro Betongspackel has an unacceptable performance when topcoated with either of the two water-based epoxy finishes.

3. The Alcro Betongspackel has an acceptable performance when topcoated with Phenoline 305 or Carboline 195 Surfacer.

PROCEDURE:

A. Test Coupon

2" x 5" x 1" Clean Concrete Block

From the Carboline Research & Development Laboratory

TESTING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

PROCEDURE: "Continued"

B. Systems Tested

System	Coats	*Total Dry Film Thickness (DFT)
1.	1c Carboline 195 Surfacer 2c Phenoline 305 Finish	25 - 35 Mil
2.	1c Carboline 195 Surfacer 2c Carboline X2191-149 (High Build water-based epoxy finish)	25 - 35 Mil
3.	1c Betongspackel 2c Phenoline 305 Finish	25 - 35 Mil
4.	1c Betongspackle 1c Carboline 195 Surfacer 2c Phenoline 305 Finish	40 - 60 Mil
5.	1c Betongspackle 1c Carboline 195 Surfacer 2c Carboline X2191-149	40 - 60 Mil
6.	1c Betongspackle 2c Carboline X2191-149	25 - 35 Mil
7.	1c Betongspackle 2c Carboline X2191-154 (Glossy water-based epoxy finish)	25 - 35 Mil
8.	1c Carboline X2191-158 (water-based epoxy surfacer) 2c Phenoline 305 Finish	25 - 35 Mil
9.	1c Carboline X2191-158 2c Carboline X2191-149	25 - 35 Mil
10.	1c Carboline X2191-158 2c Carboline X2191-154	23 - 33 Mil

TESTING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

PROCEDURE: "Continued"

*NOTE: All film thickness values were obtained by measuring the Wet Film Thickness immediately after application of the coating and calculating the Dry Film Thickness from the Percent Solids for the material being applied.

Please refer to Coating Application in the "Discussion of Results".

C. Cure Schedule

Carboline 195 Surfacer, 2 weeks + at R.T.
Phenoline 305 Finish, 24 hrs. at R.T. between coats
Carboline X2191-149, 24 hrs. at R.T. between coats
Betongspackle, 1 week at R.T.
Carboline X2191-154, 24 hrs. between coats
Carboline X2191-158, 2 weeks at R.T.

After application of all the coating systems had been completed, they received a final cure of 4 days at Room Temperature, followed by 2 days at 130°F.

D. Exposure

ANSI N101.2, BWR-PWR:

a. Water Chemistry: 1 liter demineralized water solution containing 17.3g Boric Acid, 15.3g Sodium Thiosulfate and 6g Sodium Hydroxide.

b. Time-Temperature-Pressure Profile:

Time Lapse	Temperature	Pressure
1 second	260°F	35 psig
10 seconds	295°F	55 psig
1 min., 40 sec.	280°F	59 psig
16 min., 40 sec.	255°F	58 psig
2 hrs., 47 min.	245°F	30 psig
27 hrs., 47 min.	220°F	19 psig
5 days	180°F	17 psig
11 days, 2 hrs., 40 min.	150°F	16 psig

From the Carboline Research & Development Laboratory

TESTING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

PROCEDURE: "Continued"

*NOTE: The samples were removed from the test exposure after 27 hrs., 47 min. and evaluated for an interim report. The coupons having an unacceptable performance were removed at this time, and the remaining samples returned to the test chamber for completion of the required time-temperature profile.

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:

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 of Testing and Materials, Philadelphia, Pa. 19103. The number and the size of blisters shall be recorded.

TESTING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

GRADING
PROCEDURE: "Continued"

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 the 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.

RESULTS:

Coating System	Dry Film Thickness	Flaking	Delamination and/or Peeling	Blistering	Chalking	Performance Evaluation
1. 1c Carboline 195 Surfacer 2c Phenoline 305 Finish	15-25 mils 5 mils/ct.	10	None	10	10	Acceptable
2. 1c Carboline 195 Surfacer 2c Carboline X2191-149	15-25 mils 5 mils/ct.	10	None	10	10	Acceptable Note 1.
3. 1c Betongspackle 2c Phenoline 305 Finish	15-25 Mils 5 mils/ct.	10	None	10	10	Acceptable
4. 1c Betongspackle 1c Carboline 195 Surfacer 2c Phenoline 305 Finish	15-25 mils 15-25 mils 5 mils/ct.	10	None	10	10	Acceptable
5. 1c Betongspackle 1c Carboline 195 Surfacer 2c Carboline X2191-149	15-25 mils 15-25 mils 5 mils/ct.	10	None	10	10	Acceptable Note 1.
6. 1c Betongspackle 2c Carboline X2191-149	15-25 mils 5 mils/ct.	10	Severe delamination of the Betongspackle	Extensive & large blistering of entire coupon	10	Not Acceptable Note 2.
7. 1c Betongspackle 2c Carboline X2191-154	15-25 mils 5 mils/ct.	Moderate	Severe delam. & peel of the Betongspackle	Severe blist. of entire coupon, not intact.	10	Not Acceptable Note 2.
8. 1c Carboline X2191-158 2c Phenoline 305 Finish	15-25 mils 5 mils/ct.	10	None	10	10	Acceptable
9. 1c Carboline X2191-158 2c Carboline X2191-149	15-25 mils 5 mils/ct.	10	None	10	10	Acceptable Note 1.
10. 1c Carboline X2191-158 2c Carboline X2191-154	15-25 mils 4 mils/ct.	10	None	8F, intact over 10% of the surface	10	Acceptable
Acceptable Performance		10	None	4F	6	

Note 1. There was a slight to moderate softening of the X2191-149 water based topcoat immediately after the removal of the coupon from immersion in the test solution. After cooling down to ambient temperature this softness was no longer evident.

Note 2. These samples were removed from test after the initial 27 hrs., 47 min. of the exposure. (Re: 01228 Interim Report)

From the Carboline Research & Development Laboratory

LABORATORY TEST REPORT

carboline

LABORATORY TEST REPORT

October 1, 1973/Page 7

TING PROJECT: 01228
Final Report: 11 days, 2-3/4 hours

DISCUSSION OF RESULTS:

Coating Application

The Betongspackle and Carboline 195 Surfacer samples were sanded to a relatively smooth finish after each application. Areas on the panels where the sanding exposed the concrete received a touch-up with the topcoat which was to be applied.

After the second coat of Phenoline 305 Finish had been applied to samples 1.) and 3.), the coupons were touched-up by brushing on Phenoline 305 Finish to fill voids resulting from the uneven application of the surfacer. This additional spot application of Phenoline 305 Finish did not affect the overall performance of the systems.

Coating Performance

The Betongspackel Surfacer had an acceptable performance only when top-coated with a Phenoline 305 or Carboline 195 Surfacer.

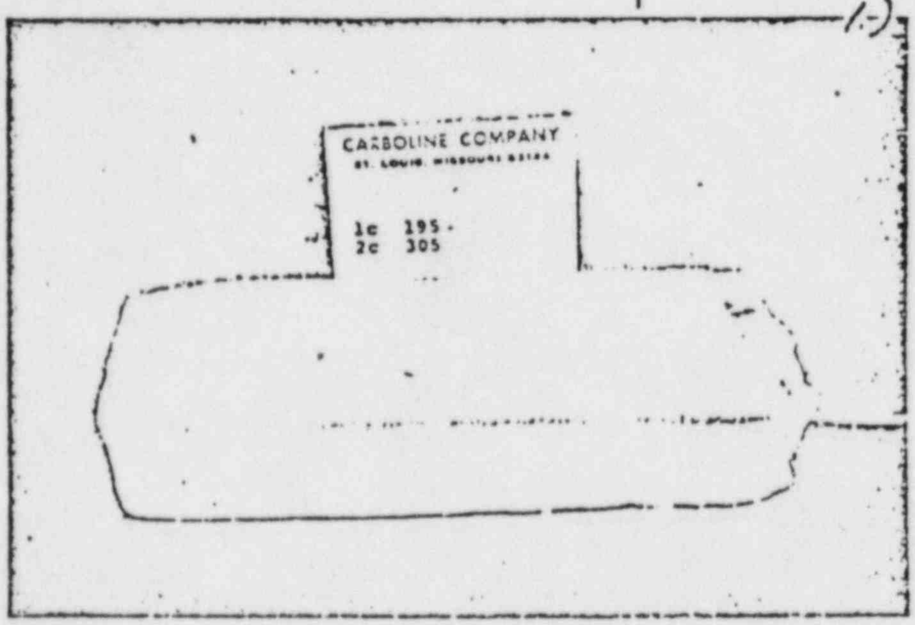
The apparent reason for this is the 195 and 305 have good water resistance and moisture does not penetrate to the Betongspackle. The water resistance, however, of the water-based topcoats is not as good and moisture penetrates to the Betongspackel, causing it to severely soften and crack.

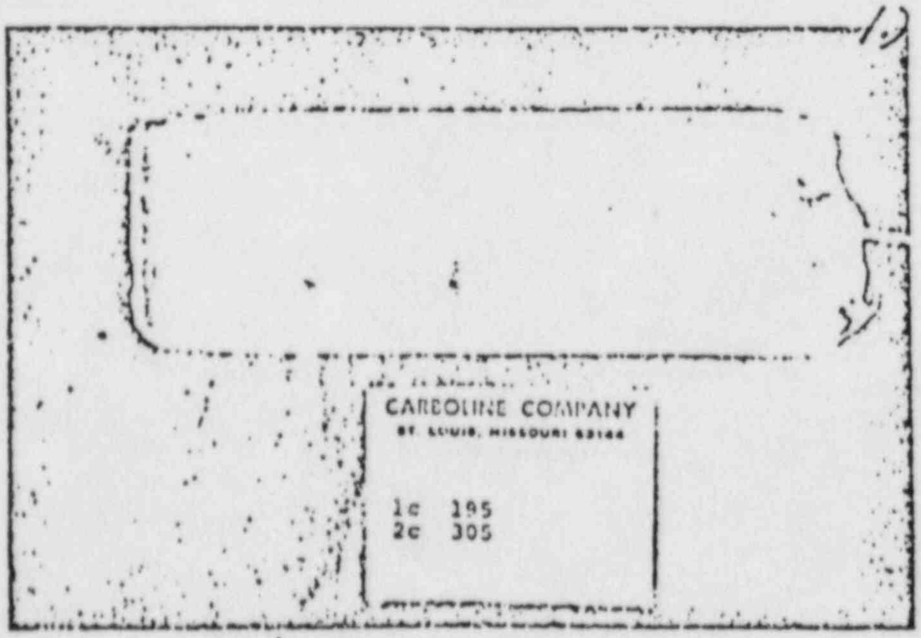
Please refer to Testing Project 01228, Interim Report for a photograph of each test coupon after exposure to the initial 27-3/4 hours of the specified test criteria.

Daniel R. Lerltz
Testing Department

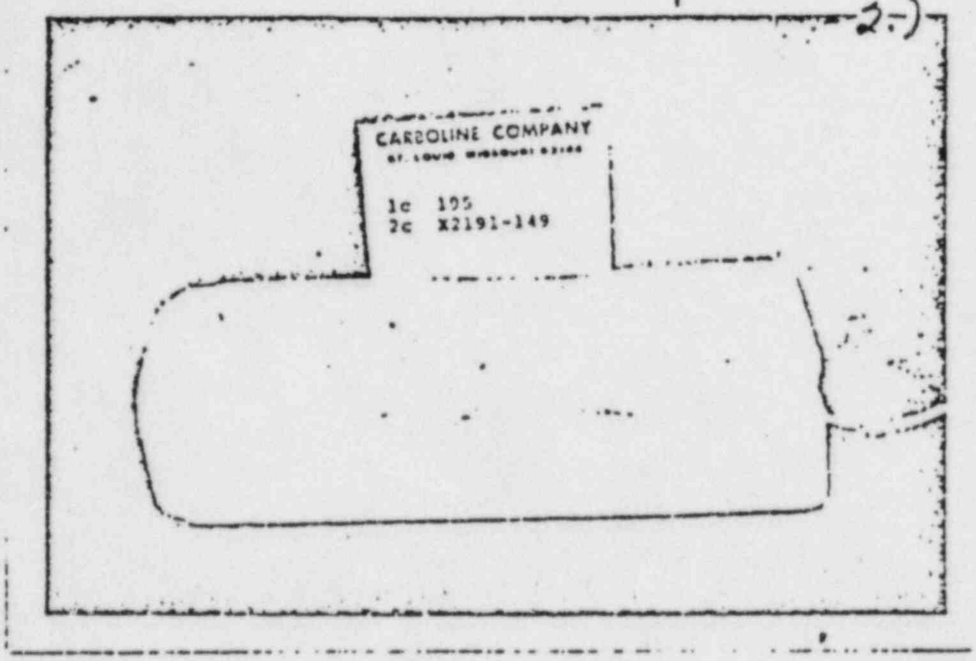
DRJ: rg
049/959/674/981/979/560/467/050
OR: Testing Department
XC: SLL/RRR/HDT/JFM/EWS/JDB/GHD/SLS/JRL/Lab Group Leaders/File

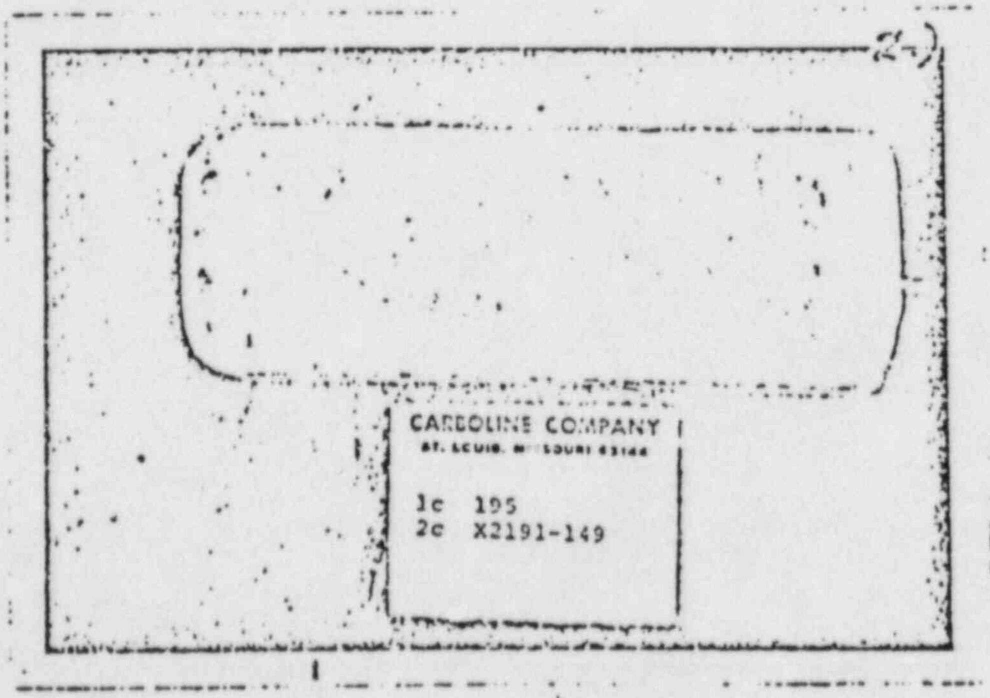
THE ATTACHED PHOTOGRAPHS SHOW EACH SYSTEM AFTER THEY HAVE BEEN EXPOSED TO THE INITIAL TEST CRITERIA IN THIS REPORT. THERE IS BOTH A TOP VIEW AND A SIDE VIEW OF EACH TEST COUPON. THE PHOTOGRAPHS ARE NUMBERED TO COINCIDE WITH THE SYSTEMS AS THEY ARE DISUCSSED IN THE REPORT.





From the Carboline Research & Development Laboratory

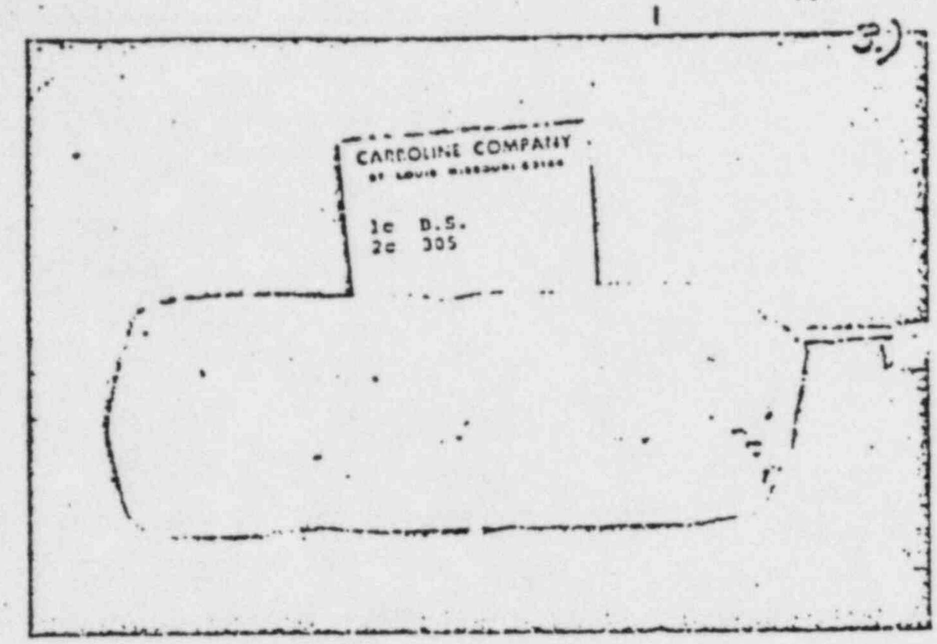


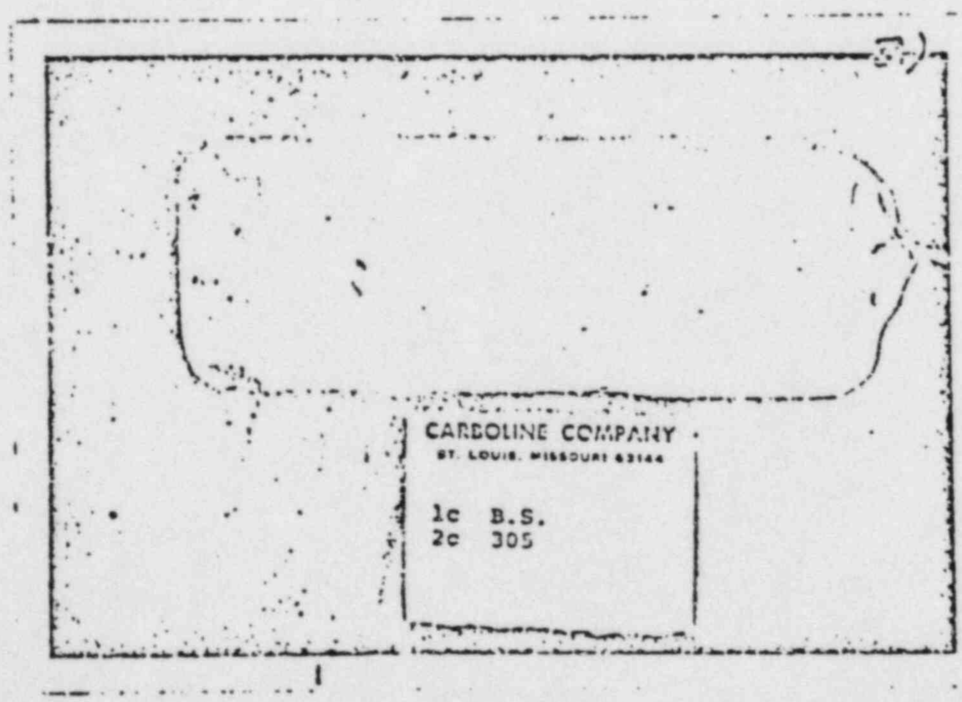


From the Carboline Research & Development Laboratory

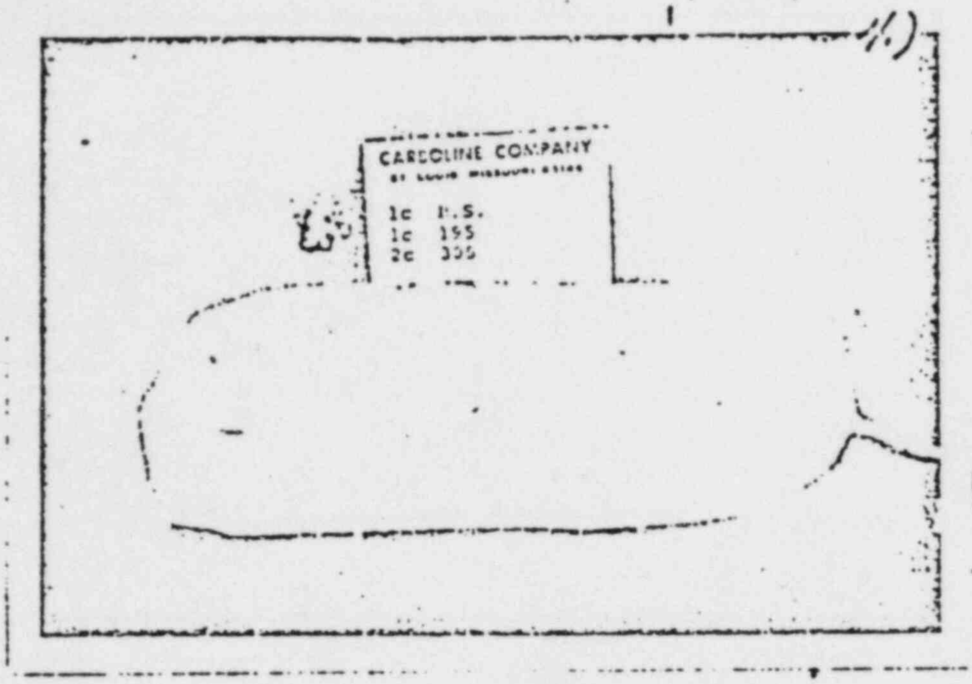
LABORATORY TEST REPORT

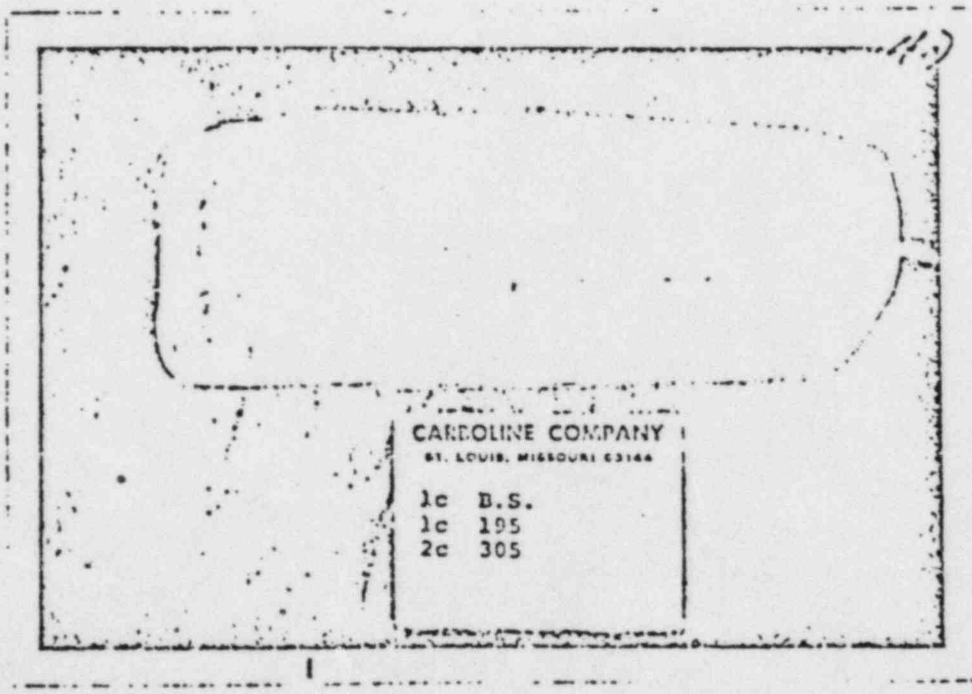
(3)





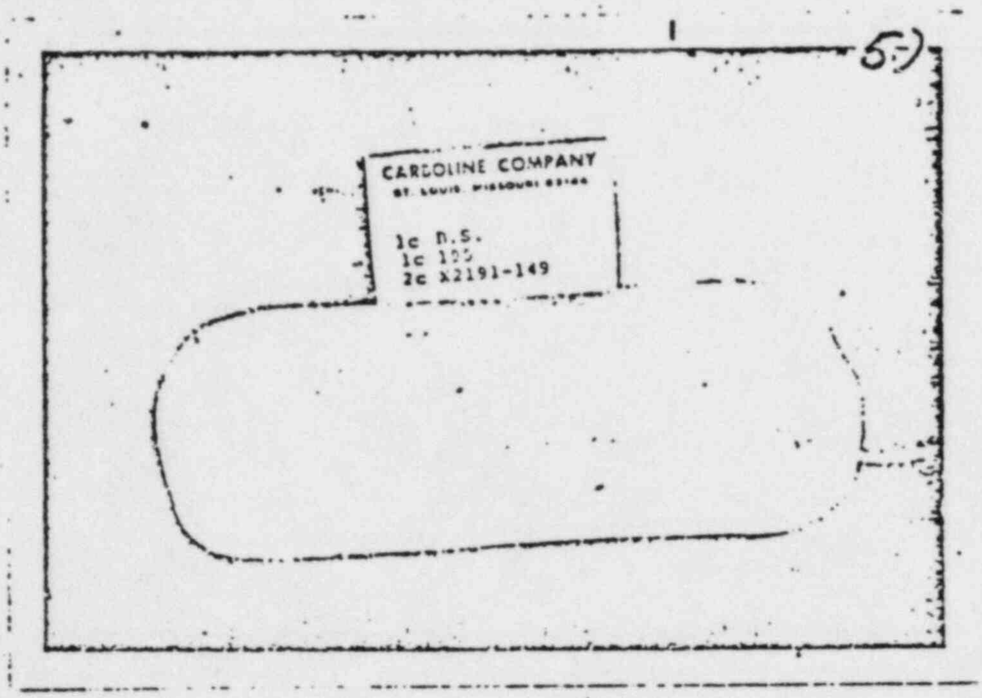
From the Carboline Research & Development Laboratory

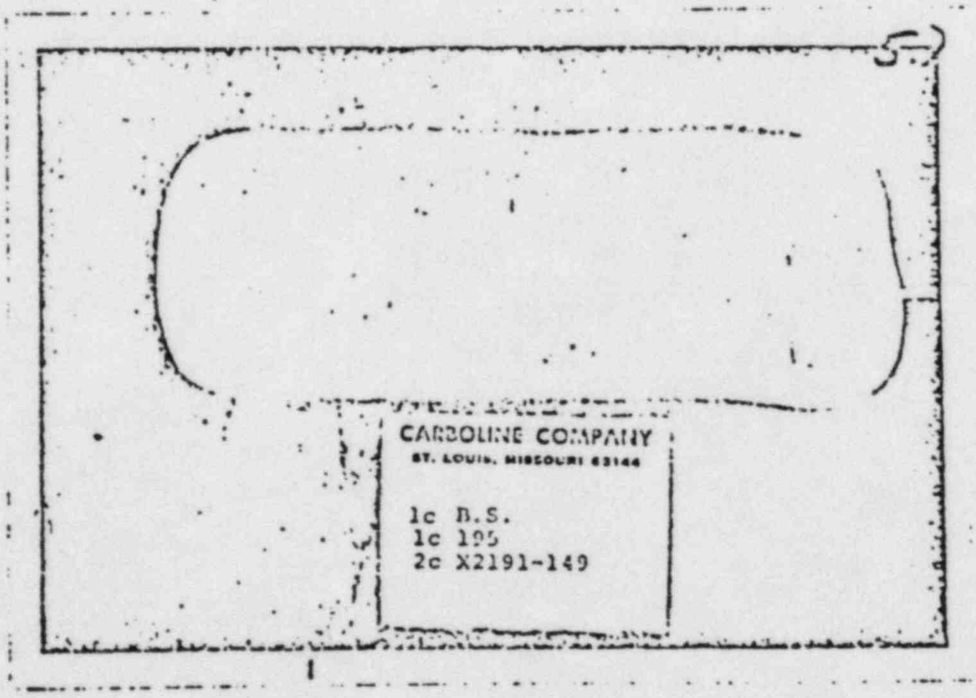




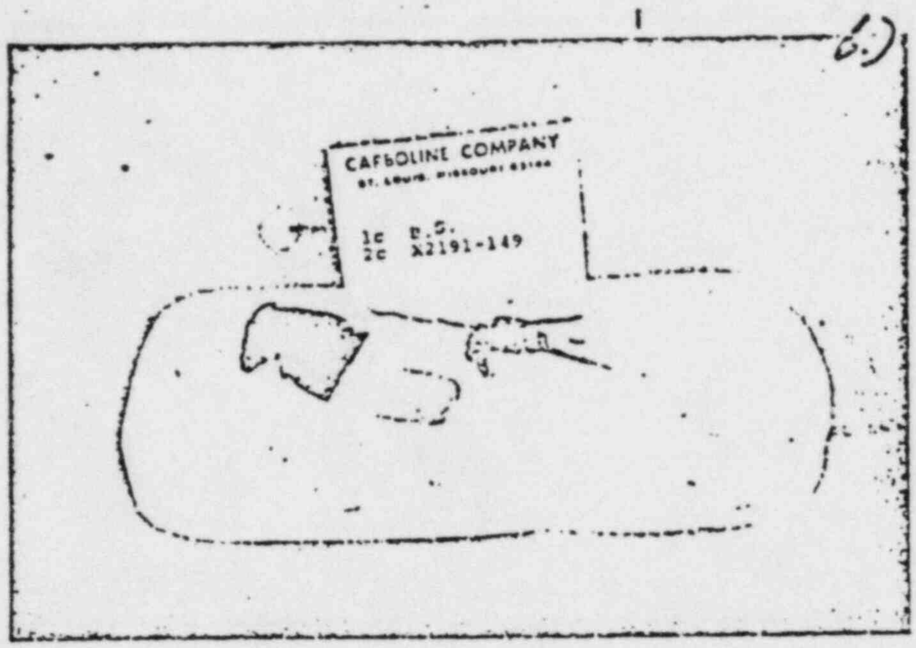
From the Carboline Research & Development Laboratory

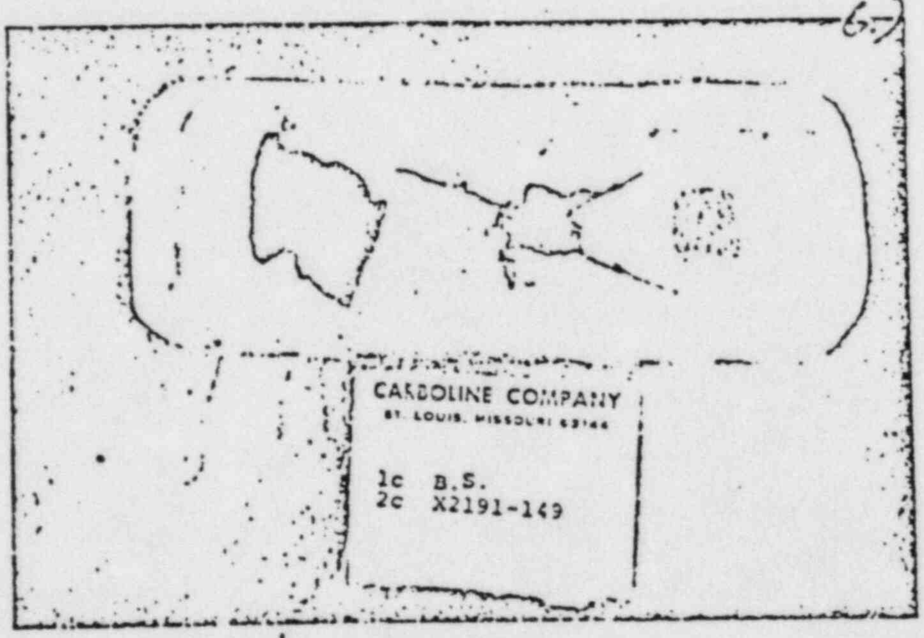
LABORATORY TEST REPORT



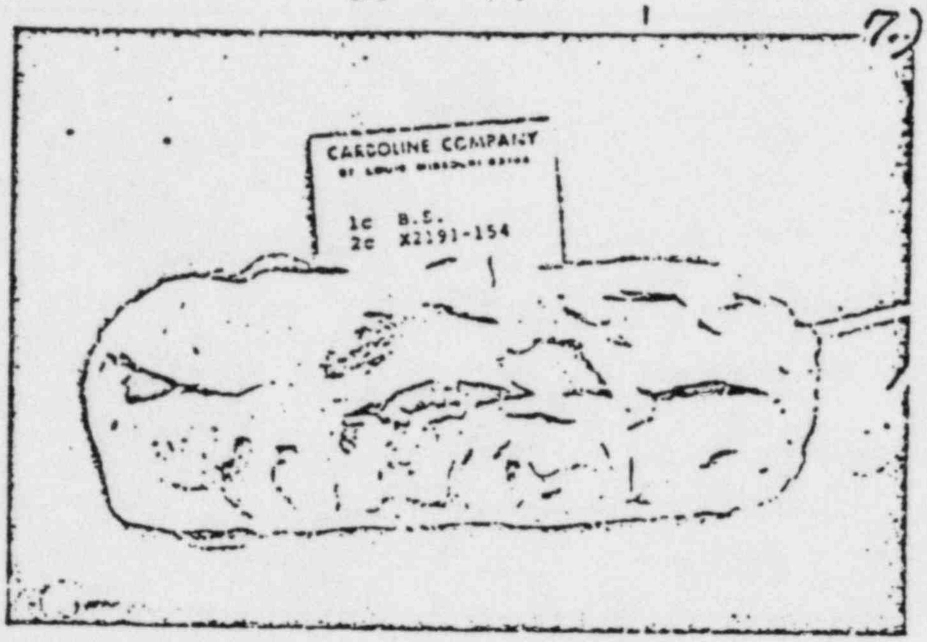


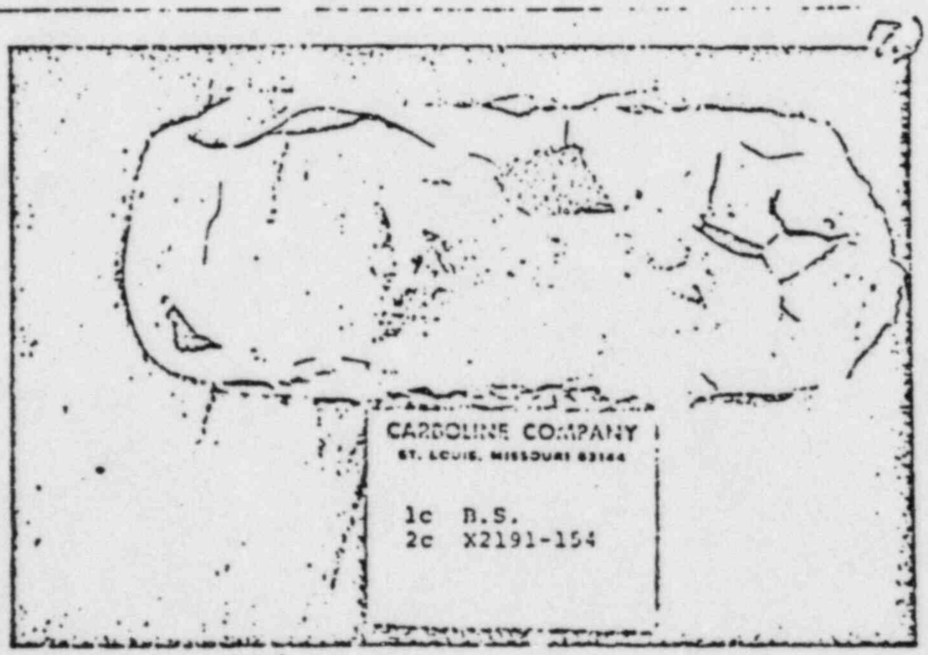
From the Carboline Research & Development Laboratory





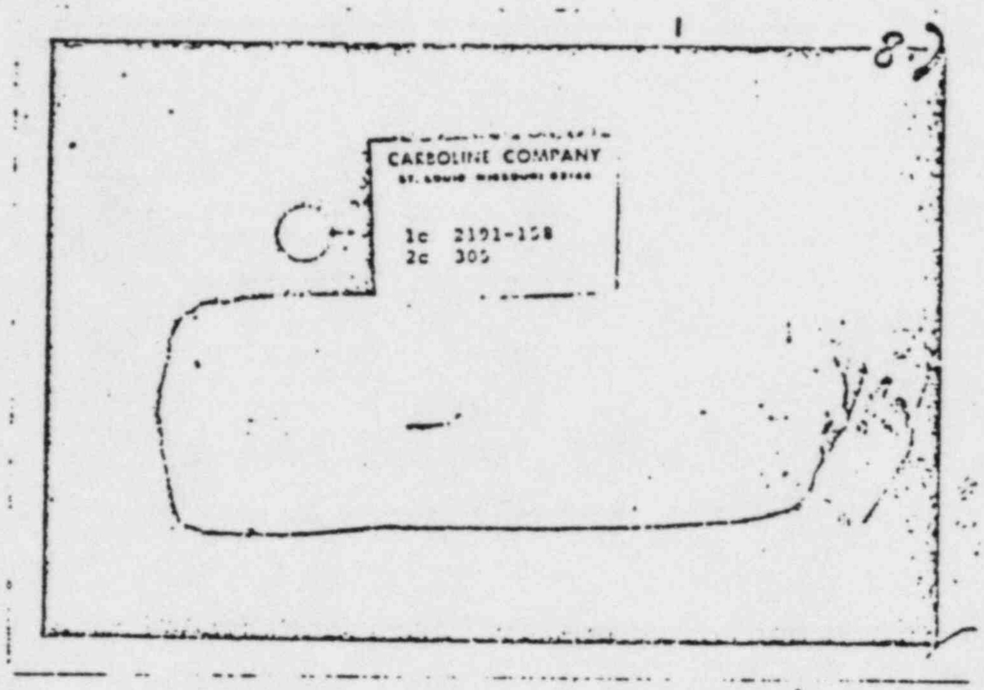
From the Carboline Research & Development Laboratory

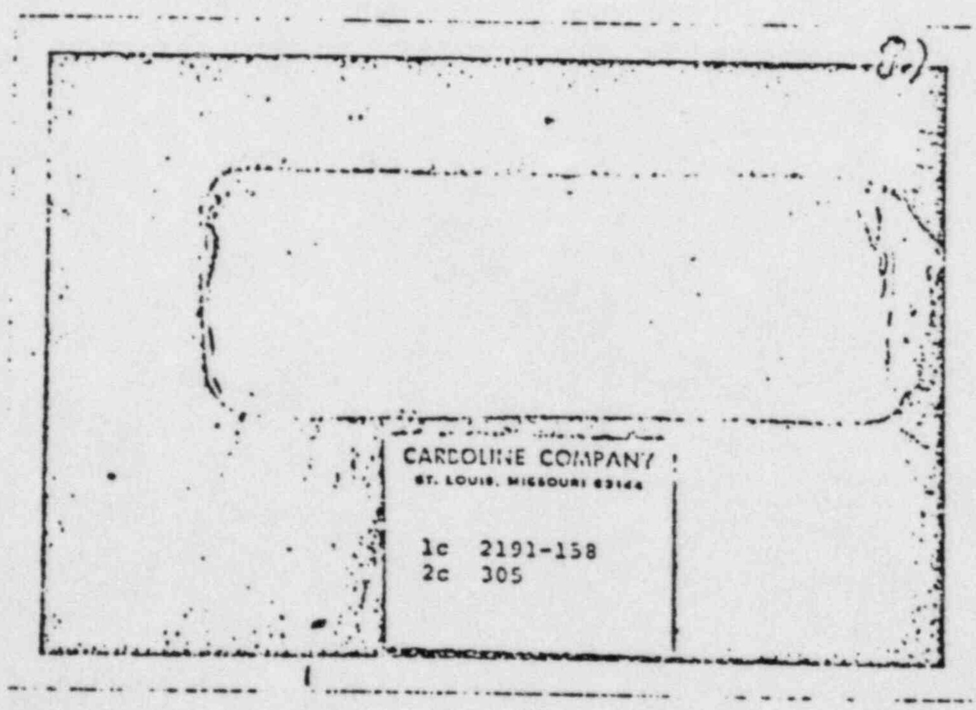




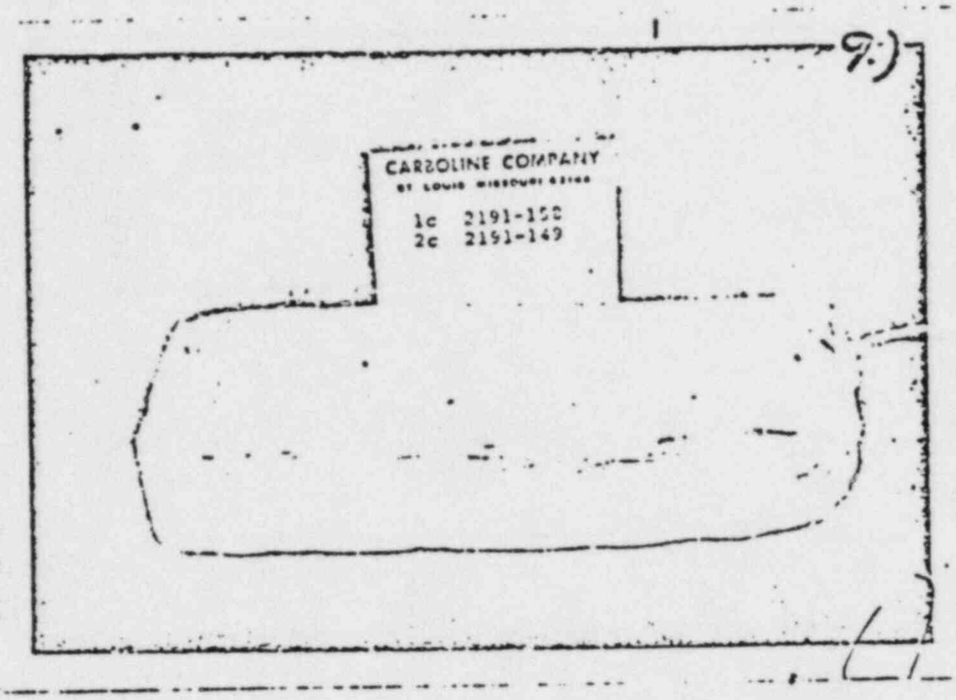
From the Carboline Research & Development Laboratory

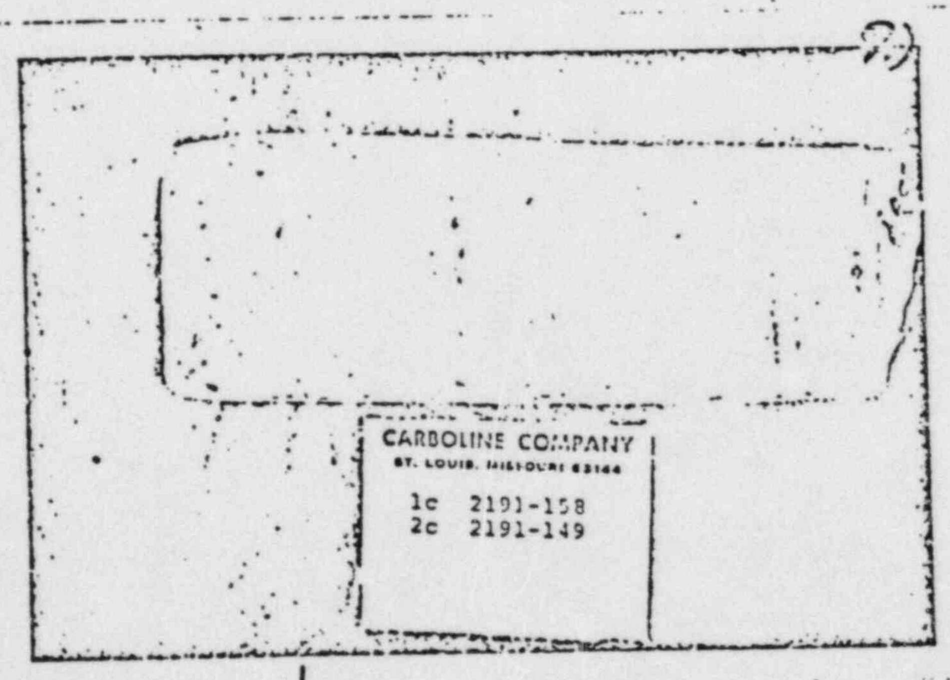
LABORATORY TEST REPORT
(8)



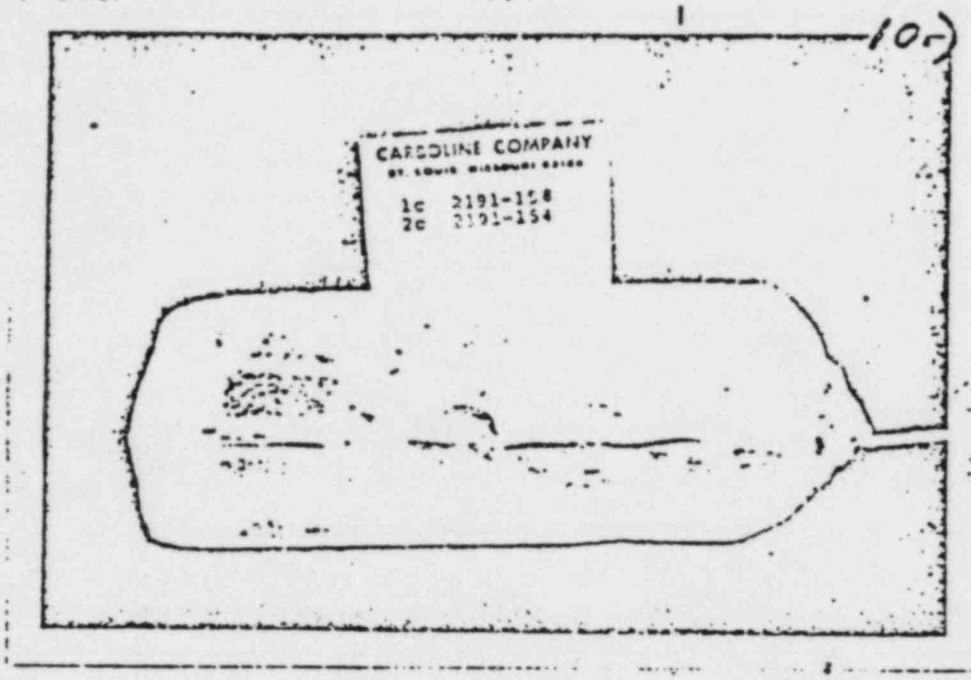


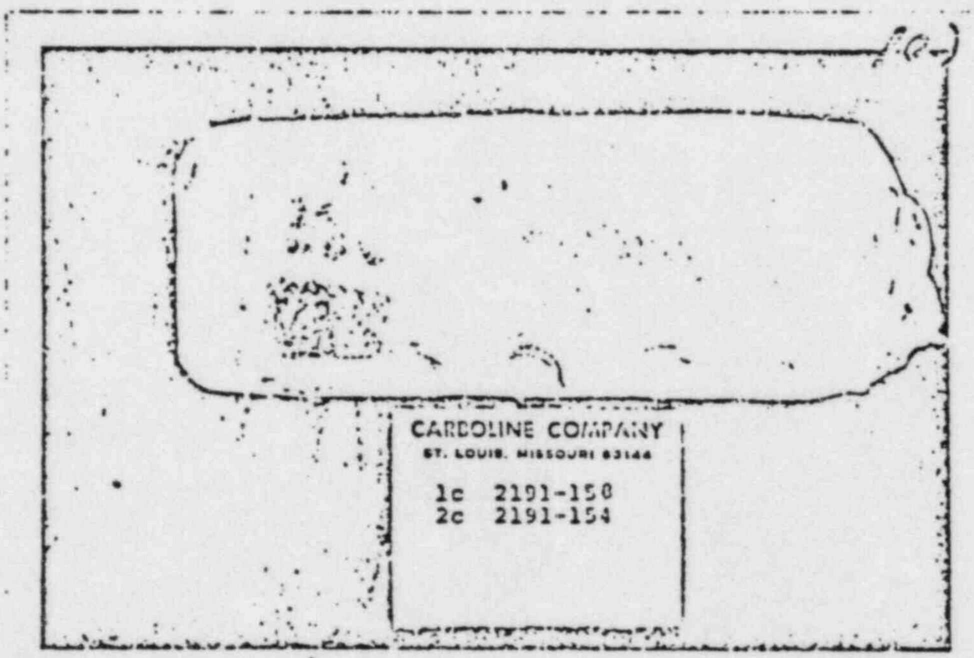
From the Carboline Research & Development Laboratory





From the Carboline Research & Development Laboratory





From the Carboline Research & Development Laboratory

LABORATORY TEST REPORT

December 18, 1973

TESTING PROJECT: 01255
Final Report: 30 Days

SUBJECT: LOCA evaluation tests for Liner Plate Coatings, Midland Units 1 and 2.

REFERENCE: Mr. P.A. Martinez, Bechtel; Mr. William Matheney, Consumers Power Company; Mr. James R. Lopata; Mr. John Hill.

PURPOSE: To evaluate the Carbo Zinc 11/Phenoline 305 coating system when applied over test panels cut from the liner plates of the Midland Plant Reactor Containment Building and subjected to the test exposure criteria specified under the "DBA Environmental Test Curve" for Midland Plant, Units 1 and 2.

CONCLUSION: It can be concluded that the Carbo Zinc 11/Phenoline 305 system is exhibiting an acceptable performance after exposure to this 30-day test when evaluated according to the ANSI N101.2-1972, Section 4.5 guidelines for examining exposed test specimens. Please refer to "Results".

PROCEDURE:

A) Test Coupon
2-1/8" x 4-1/8" x 1/4" sandblasted steel

B) System Tested
1c Carbo Zinc 11
1c Phenoline 305 Finish

DFT
Please refer to "Results"

C) Cure Schedule
Carbo Zinc 11, 24 hours at 100% humidity
Phenoline 305 Finish, 48 hours at R.T. plus overnight at 130°F.

D) Exposure
DBA Environmental Test for Liner Plate Coatings, Midland Plant Units 1 and 2. Bechtel Job Reference No. 7220. Time-temperature-pressure criteria dated November 23, 1973.

1) Water Chemistry
Demineralized water test solution containing:

Boric Acid 13,000 ppm
Sodium Thiosulfate - 18,000 ppm
pH adjusted to 9.5 with Reagent Grade Sodium Hydroxide

2) Time-Temperature-Pressure Profile
This test began at atmospheric pressure and was kept at saturation pressure* throughout the complete cycle.

TESTING PROJECT: 01255
Final Report: 30 Days

PROCEDURE: (Continued)

Total Time Lapse	Temperature	Pressure*
Initial	Ambient	---
0.1 Second	316°F	70 psig
25 Minutes	316°F	70 psig
4 Hours	280°F	45 psig
1 Day	240°F	20 psig
30 Days**	200°F	10 psig

**The test coupons were evaluated after the initial 14 days of exposure to the above profile for development of an interim report. They were then returned to the chamber for completion of the test.

All test coupons were partially immersed into the solution inside the test chamber, and scribed down to the steel substrate before being exposed.

COATING APPLICATION:

Substrate: Carbon Steel blasted to a SSPC white metal surface, 1-1/2 to 2 mil profile.
Blast Abrasive: 2 parts 5330 Steel Shot, 1 part G40 steel grit.

Carbo Zinc 11: 10/31/73 - Date of Application
Batch #: 3G5528 Color: Green
Room Temperature °F: 75 Surface Temperature °F: 70
Relative Humidity: 32%
Cure: 24 hours in a Water Fog Environment

Phenoline 305 Finish: 11/1/73 - Date of Application
Batch # (Finish): 2B3686 Color: White
Batch # (Catalyst): 1L3069
Room Temperature °F: 74 Surface Temperature °F: 70
Relative Humidity: 24%
Cure: 48 hours at room temperature
Final Cure: Overnight at 130°F.

GRADING PROCEDURE:
(December, 1973)

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

TESTING PROJECT: 01255
Final Report: 30 Days

GRADING
PROCEDURE: (Continued)

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:

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, Pennsylvania 19103. Flaking shall not be permitted.

4.5.2 Delamination and/or Peeling. Delaminaition 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, Pennsylvania 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, Pennsylvania 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	Blister Size	Blister Density
	#2	None
	#4	Few

TESTING PROJECT: 01255
Final Report: 30 Days

GRADING
PROCEDURE: (Continued) Maximum Degree of Failure Allowable

	Blister Size	Blister Density
*Blistering ASTM D714-56 (Cont.)	#6	Medium
	#8	Medium-Dense

*Note: A blister is not intact when it has resulted in coating being separated from the test coupon.

Chalking 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.

TESTING PROJECT: 01255
Final Report: 30 Days

December 18, 1973/Page 5.

RESULTS:

Coating System and ID	Average Dry Film Thickness	Flaking	Delamination or Peeling	Blistering	Chalking	Performance Evaluation
4A: $1A_1$) 1c Carbo Zinc 11 1c Phenoline 305	3.2 4.8/8.0	10	None	#4F to #2F, Cracked	10	Acceptable
$1A_2$)* 1c Carbo Zinc 11 1c Phenoline 305	3.75 5.05/8.8	10	None	Three, #4 to #2, Cracked	10	Acceptable (1)
5A: $1B_1$) 1c Carbo Zinc 11 1c Phenoline 305	3.2 4.6/7.8	10	None	10	10	Acceptable
$1B_2$)* 1c Carbo Zinc 11 1c Phenoline 305	3.6 4.5/8.1	10	None	10	10	Acceptable (2)
6A: $3A_1$) 1c Carbo Zinc 11 1c Phenoline 305	3.4 4.1/7.5	10	None	10	10	Acceptable
$3A_2$)* 1c Carbo Zinc 11 1c Phenoline 305	3.6 4.0/7.6	10	None	10	10	Acceptable (3)
Acceptable Performance		10 (None)	None	4F to 8MD	8 (Light)	

*Duplicate side of coupon receiving scribe.
(1) 1/16" undercutting from scribe, coating is intact.
(2) 2/16" undercutting from scribe, coating is intact.
(3) 2/16" undercutting from scribe, coating is intact. Small amount of coating has been chipped away to evaluate extent of undercutting. This was done after completion of the test.

NOTE: The dry film thickness for each coupon is the average of readings taken at the top, middle, and bottom of the test panel. This data is available in the project record file.

From the Carboline Research & Development Laboratory

LABORATORY TEST REPORT

carboline

LABORATORY TEST REPORT

TESTING PROJECT: 01255
Final Report: 30 Days

DISCUSSION OF RESULTS:

There was a moderate cracking on the edges of the exposed test coupons. However, the coating remains intact and this cracking was ignored in the performance evaluation.

Please refer to the attached photographs for a visual description of the test coupons after completion of the test cycle.

Daniel R. Leritz
Group Leader - Testing

John F. Montle
Director of Research

DRL/JFM:jn
OR: Testing Department
XC: Mr. William Matheney, Consumer Power Company
SLL
RRR
HDT
JFM
JDB
EWS
GHD
SLS
JRL
LAB GROUP LEADERS

From the Carboline Research & Development Laboratory

{carboline}

Product Name: CARBO ZINC 11

PRODUCT IDENTITY CERTIFICATION RECORD

GENERAL DATA
(To Be Filled In By Purchaser)

Project Designation ______________ Date ______________

Project Location ______________ Report No. ______________

Owner ______________ Purchase Order No. ______________

Building, Unit, or Equipment Designation: ______________ Contract No. ______________

Shop Work ______________

Field Work ______________

TECHNICAL DATA

Date :-23-74

Coating Manufacturer: CARBOLINE CO., 328 Hanley Ind. Ct., St. Louis, Mo. 63144

Product Name and Number Carbo Zinc 11 Generic Type Inorganic Zinc

Batch No. 305528 Date of Manufacture 8-13-73 Shelf Life 9 Months

Net Weight, Lbs. Per Gallon -- (By [X] Fed. Test Method Std. No. 141, Method 4184 † or By [ ] ASTM D1475)
9.00 lbs.

Viscosity Range 50-60 KU Temperature 75 °F. Method Krebs Stormer

Solids Volume % † 1000 mil ft. per gallon

Dry Time: 8-12 Hours @ 60-85 °F. 50 % R.H.

Tack Free Time: 1/4 Hours @ 60-85 °F. 50 % R.H.

Recoat Time Range: 8-12 Hrs. @ 60-85 °F. 50 % R.H.

Minimum Dry Film Thickness Per Coat: 2-1/2 - 3 Mils

Color, Visual ______________

Mixing Ratio: 33 lbs. Parts Carbo Zinc #11 Resin Component

By Wt. X 73 lbs. Parts Carbo Zinc #11 Filler Component

By Vol. ______ ______ Parts ______ Component

Induction Period Not Required Hours @ ______ °F.

Pot Life 8 Hours @ 75 °F.

Specified Thinner Thinner #33

Flash Point Tag Open Cup 86 °F.☆ (ASTM D-92)

☆ Mixed ready to spray

Signature David [illegible]

Distribution:

Title PRODUCTION SERVICES SUPT.

carboline

Product Name: PHENOLINE 305 FINISH

PRODUCT IDENTITY CERTIFICATION RECORD

GENERAL DATA
(To Be Filled In By Purchaser)

Project Designation ______ Date ______

Project Location ______ Report No. ______

Owner ______ Purchase Order No. ______

Building, Unit, or Equipment Designation: ______ Contract No. ______

Shop Work ______

Field Work ______

TECHNICAL DATA

Date 1-23-74

Coating Manufacturer: CARBOLINE CO., 328 Hanley Ind. Ct., St. Louis, Mo. 63144

Product Name and Number Phenoline 305 Finish Generic Type Modified Phenolic

Batch No. 253686 Date of Manufacture 3-14-73 Shelf Life 2 Years

Net Weight, Lbs. Per Gallon -- (By [X] Fed. Test Method Std. No. 141, Method 4184 ± or By [ ] ASTM D1475)
11.74 lbs.

Viscosity Range 73-83 KU Temperature 75 °F. Method Krebs Stormer

Solids Volume % ± 72% ± 1%

Dry Time: 18 Hours @ 75 °F. 50 % R.H.

Tack Free Time: 9 Hours @ 75 °F. 50 % R.H.

Recoat Time Range: 18 Hrs. @ 75 °F. 50 % R.H.

Minimum Dry Film Thickness Per Coat: 3-4 Mils

Color, Visual ______

Mixing Ratio: 4 Parts Phenoline 305 Finish Resin Component

By Wt. ______ Parts ______ Component

By Vol. X , 1 Parts Phenoline 305 Finish Catalyst Component

Induction Period Not Required Hours @ ______ °F.

Pot Life 1-1/2 Hours @ 75 °F.

Specified Thinner Phenoline Thinner

Flash Point Tag Open Cup 215 °F. (ASTM D-92)

Signature David Zimmer

Title PRODUCTION SERVICES SUPT.

Distribution:

carboline

Product Name: PHENOLINE 305 FINISH CATALYST

PRODUCT IDENTITY CERTIFICATION RECORD

GENERAL DATA

(To Be Filled In By Purchaser)

Project Designation ______ Date ______

Project Location ______ Report No. ______

Owner ______ Purchase Order No. ______

Building, Unit, or Equipment Designation: ______ Contract No. ______

Shop Work ______

Field Work ______

TECHNICAL DATA

Date 1-23-74

Coating Manufacturer: CARBOLINE CO., 328 Hanley Ind. Ct., St. Louis, Mo. 63144

Product Name and Number Phenoline 305 Finish Catalyst Generic Type Modified Phenolic

Batch No. 113069 Date of Manufacture 12-22-71 Shelf Life 2 Years

Net Weight, Lbs. Per Gallon -- (By [X] Fed. Test Method Std. No. 141, Method 4184 ± or By [ ] ASTM D1475)

7.68 lbs.

Viscosity Range N/A Temperature ______ °F. Method ______

Solids Volume % ± N/A

Dry Time: 18 Hours @ 75 °F. 50 % R.H.

Tack Free Time: 9 Hours @ 75 °F. 50 % R.H.

Recoat Time Range: 18 Hrs. @ 75 °F. 50 % R.H.

Minimum Dry Film Thickness Per Coat: 3-4 Mils

Color, Visual Clear

Mixing Ratio: 4 Parts Phenoline 305 Finish Component

By Wt. ______ ______ Parts ______ Component

By Vol. X 1 Parts Phenoline 305 Finish Catalyst Component

Induction Period Not Required Hours @ ______ °F.

Pot Life 1-1/2 Hours @ 75 °F.

Specified Thinner Phenoline Thinner

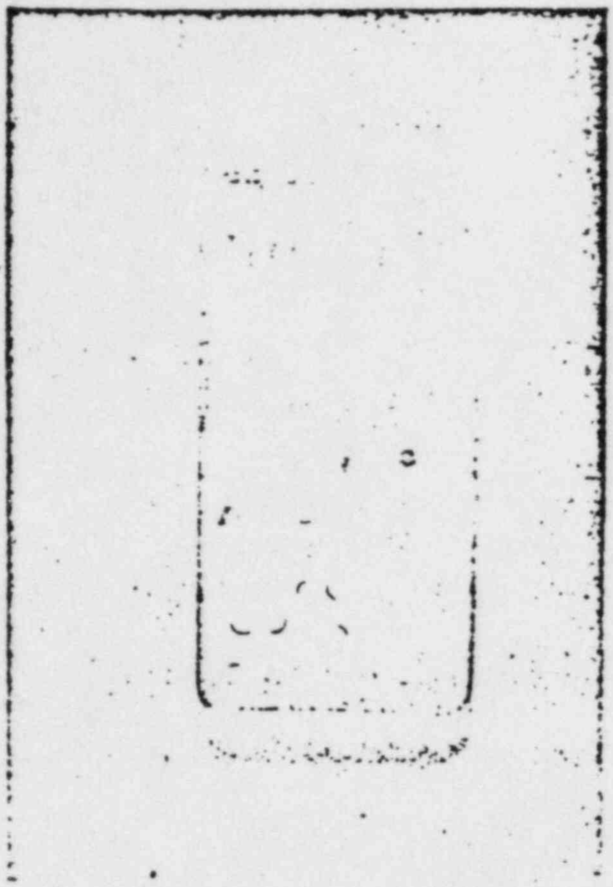
Flash Point Tag Open Cup 88 °F. (ASTM D-92)

Signature David Jimmie[?]

Title PRODUCTION SERVICES SUPT.

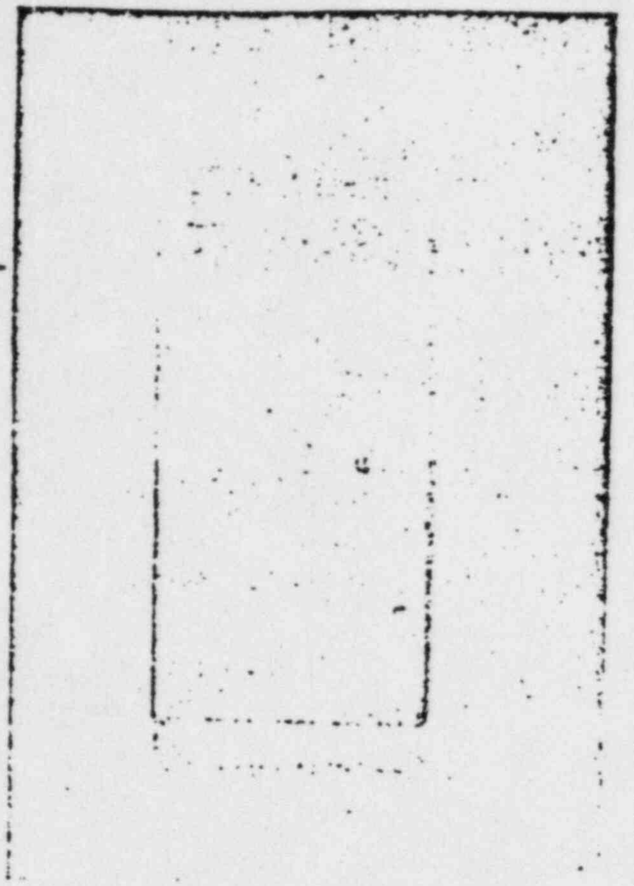
Distribution:

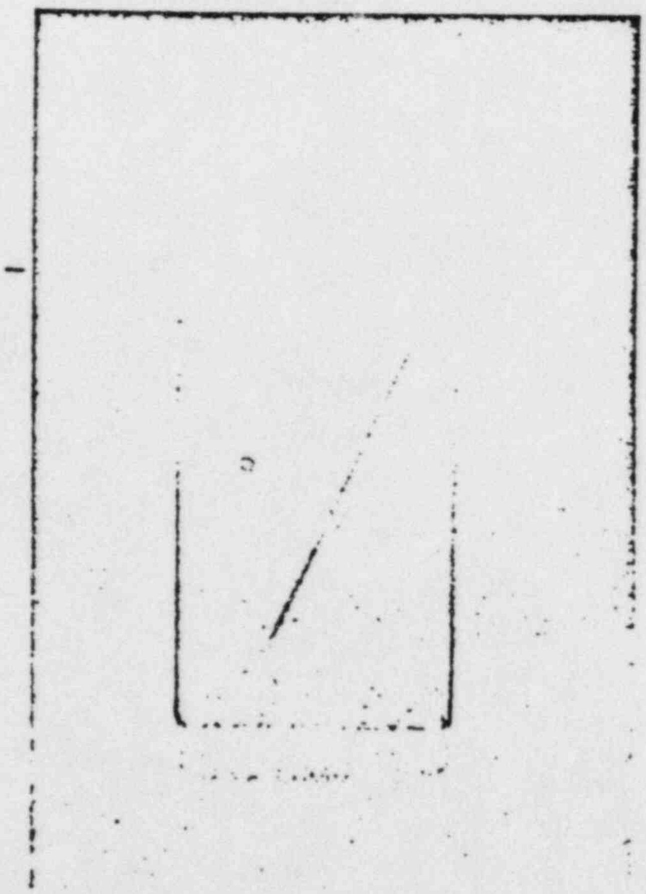
LABORATORY TEST REPORT



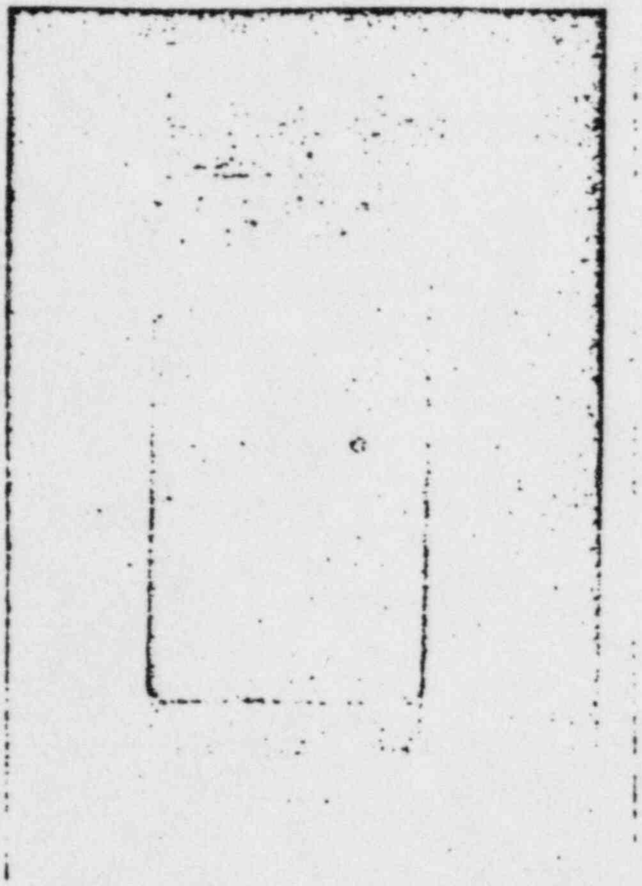
From the Carboline Research & Development Laboratory

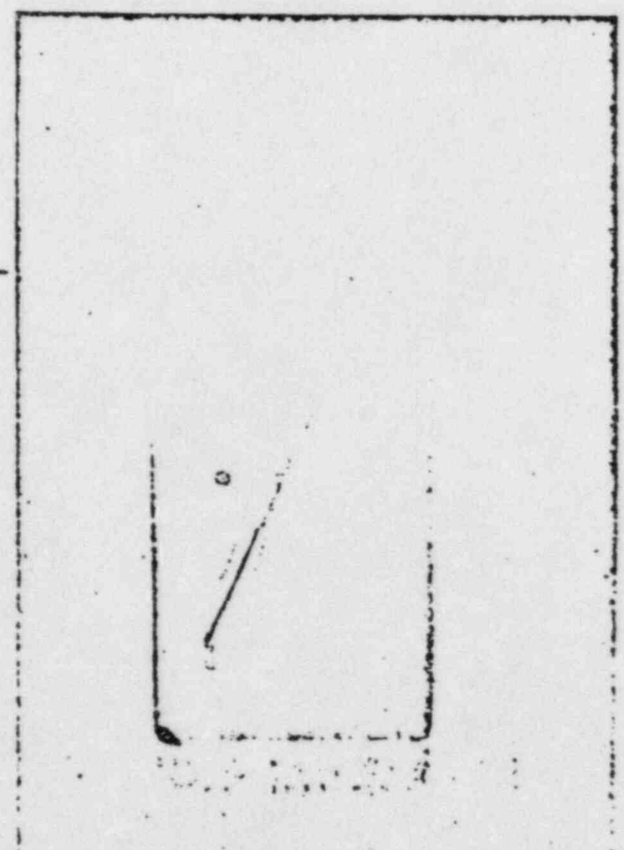
LABORATORY TEST REPORT





From the Carboline Research & Development Laboratory





LABORATORY TEST REPORT

TESTING PROJECT: 01377
FINAL REPORT - 100 DAYS

December 23, 1975

SUBJECT: LOCA testing of Carbo Zinc 11 at various thicknesses alone and topcoated with Phenoline 305.

REFERENCE: Mr. Chris Kjaer - Olsen, General Electric; Mr. Charles J. Wiegers, Carboline Master BWR Curve.

PURPOSE: To evaluate the performance of Carbo Zinc 11 at film thicknesses from 1 to 15 mils, both untopcoated and topcoated with Phenoline 305, when exposed to the Carboline Master BWR Curve.

CONCLUSIONS: After the 100 days of the Carboline Master BWR Curve, the following conclusions have been reached:

1) Carbo Zinc 11 is acceptable according to ANSI N101.2-1972 Section 4.5 as interpreted by Carboline at dry film thicknesses up to 12.5 mils.

2) The 1c Carbo Zinc/1c Phenoline 305 is acceptable according to ANSI N101.2-1972 Section 4.5 as interpreted by Carboline at dry film thicknesses up to 11.5 mils.

3) At dry film thicknesses in excess of those mentioned above, Carbo Zinc 11 and Carbo Zinc/Phenoline 305 are not acceptable. (Please refer to "Results")

PROCEDURE: A) Test Coupons

2" x 5" x 1/8" sandblasted steel panels (blast profile of 1 to 2 mils)

B) Systems Tested

Systems Tested	Dry Film Thickness
1) Carbo Zinc 11 (various thicknesses)	Please Refer
2) Carbo Zinc 11 (various thicknesses) Phenoline 305	to "Results"

C) Cure Schedule

Carbo Zinc 11:	24 hours at 100% humidity, between coats; 3 days at 75°F, final cure (untopcoated Carbo Zinc 11 only).
Phenoline 305:	3 days at 75°F, 24 hours at 120°F, final cure.

TESTING PROJECT: 01377
FINAL REPORT - 100 DAYS

December 23, 1975
Page 2

PROCEDURE: (Continued)

D) Exposure

Carboline Master BWR Curve
(Reference: UNWCC Draft #1; G.E. Mark III, Dry Well)

1) Water Chemistry

Deionized Water

2) Time-Temperature-Pressure Curve

Time	Temperature	Pressure*
Initial	Ambient	Ambient
Initial - 10 Seconds	332°F	106 psig
10 Seconds - 7 Minutes	250°F	30 psig
7 Minutes - 4 Hours	200°F	11.5 psig
4 Hours - 96 Hours**	180°F (Hot Soak)	7.5 psig
96 Hours - 100 Days	160°F (Hot Soak)	4.7 psig

*System was held at saturation pressure throughout the test cycle; the maximum temperature and pressure experienced by the panels was 332°F and 106 psig.

**The panels were removed from test at this time for grading and development of an interim report. They were then returned for the completion of the 100 day test cycle.

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:

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 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.

(December, 1973)

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	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 evaluated according to ASTM Standards, with a rating of 10 indicating that no failure was observed in the specific grading area.

Coating System	Dry Film Thickness (Actual Thickness)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
1A) Carbo Zinc 11	1 mil (1.5 mils)	10	None	10	10	Moderate salt deposits	Very good
1B) Carbo Zinc 11	1 mil (1.4 mils)	10	None	10	10	Moderate salt deposits	Very good
2A) Carbo Zinc 11	3 mils (2.8 mils)	10	None	10	10	Moderate salt deposits	Very good
2B) Carbo Zinc 11	3 mils (2.7 mils)	10	None	10	10	Moderate salt deposits	Very good
3A) Carbo Zinc 11	5 mils (5.0 mils)	10	None	10	10	Moderate salt deposits	Very good
3B) Carbo Zinc 11	5 mils (5.0 mils)	10	None	10	10	Moderate salt deposits	Very good
4A) Carbo Zinc 11	7 mils (6.5 mils)	10	None	10	10	Salt deposits	Very good
4B) Carbo Zinc 11	7 mils (7.0 mils)	10	None	10	10	Salt deposits	Very good
5A) Carbo Zinc 11	9 mils (9.0 mils)	10	None	10	10	Slight salt deposits; slight "mudcracking" of surface	Good
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)		

Coating System	Dry Film Thickness (Actual Thickness)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
5B) Carbo Zinc 11	9 mils (9.0 mils)	10	None	10	10	Slight salt deposits; slight "mudcracking" of surface	Good
6A) Carbo Zinc 11	11 mils (12.5 mils)	10	None	One > #2 blister, cracked but intact	10	Slight salt deposits; slight "mudcracking" of surface	Unacceptable
6B) Carbo Zinc 11	11 mils (13.5 mils)	10	None	10	10	Slight salt deposits; very slight "mudcracking"	Very good
7A) Carbo Zinc 11	15.0 mils (15.0 mils)	10	None	One #2 blister, one 1-inch blister, one side	10	One blister is cracked but intact; slight "mudcracking"	Unacceptable
7B) Carbo Zinc 11	15.0 mils (15.0 mils)	10	None	10	10	Slight salt deposits; moderate "mudcracking"	Good
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)		

Coating System	Dry Film Thickness (Actual Thickness)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
8A) Carbo Zinc 11 Phenoline 305	1 mil 1 mil (2.2 mils)	10	None	#8F-B near edges, both sides	10	Slight coating discoloration	Very good
8B) Carbo Zinc 11 Phenoline 305	1 mil 1 mil (2.1 mils)	10	None	#8M-B at one corner, one side	10	Slight coating discoloration	Good
9A) Carbo Zinc 11 Phenoline 305	3 mils 1 mil (4.0 mils)	10	None	10	10	Very slight coating discoloration	Excellent
9B) Carbo Zinc 11 Phenoline 305	3 mils 1 mil (3.6 mils)	10	None	10	9 (Very Light)	Very slight coating discoloration	Very Good
10A) Carbo Zinc 11 Phenoline 305	5 mils 1 mil (6.7 mils)	10	None	10	10	Very slight coating discoloration	Excellent
10B) Carbo Zinc 11 Phenoline 305	5 mils 1 mil (5.6 mils)	10	None	10	10	Very slight coating discoloration	Excellent
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)		

Coating System	Dry Film Thickness (Actual Thickness)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
11A) Carbo Zinc 11 Phenoline 305	7 mils 1 mil (8.0 mils)	10	None	One #4 blister, one side	10	Very slight coating discoloration	Good
11B) Carbo Zinc 11 Phenoline 305	7 mils 1 mil (7.8 mils)	10	None	10	10	Slight coating discoloration	Very good
12A) Carbo Zinc 11 Phenoline 305	9 mils 1 mil (9.5 mils)	10	None	10	10	Slight coating discoloration; surface has rough texture	Good
12B) Carbo Zinc 11 Phenoline 305	9 mils 1 mil (10.2 mils)	10	None	10	10	Slight coating discoloration	Very good
13A) Carbo Zinc 11 Phenoline 305	11 mils 1 mil (11.5 mils)	10	None	One >#2 blister, one side; #2F-B one side	10	Some blisters are cracked, but intact. Very slight coating discoloration	Unacceptable
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)		

Coating System	Dry Film Thickness (Actual Thickness)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
13B) Carbo Zinc 11 Phenoline 305	11 mils 1 mil (12.0 mils)	10	None	#4 to #6F-B, one side	10	Slight coating discoloration	Good
14A) Carbo Zinc 11 Phenoline 305	13 mils 1 mil (15.0 mils)	10	None	#2F-B, one side; #6 to #8F-B, one side	10	Very slight coating discoloration	Unacceptable
14B) Carbo Zinc 11 Phenoline 305	13 mils 1 mil (15.0 mils)	10	None	10	10	Slight coating discoloration	Very good
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)		

Patrick D. Fisher
Developmental Engineer
Testing Department

John F. Montle
Vice President
Research & Development

PDF:sh
XC: SLL/HDT/JFM/EWS/JDP/CJW/JDB/SLS/DRL/LAB GROUP LEADERS

TESTING PROJECT: 01406 December 26, 1975

FINAL REPORT - TWELVE DAYS

SUBJECT: L.O.C.A. testing of Carbo Zinc 11 at low film thicknesses, topcoated with Phenoline 305, Phenoline 368WG, and Carboline 191 HB.

REFERENCE: Bechtel 1975 L.O.C.A. Curve, Ref. CP-956; Mr. Charles J. Wiegers.

PURPOSE: To evaluate Carbo Zinc 11 at low film thicknesses, topcoated with Phenoline 305 Finish, Phenoline 368WG, and Carboline 191HB, following exposure to the Bechtel 1975 L.O.C.A. curve, Reference CP-956.

CONCLUSION: After exposure to the 12 day Bechtel 1975 L.O.C.A. criteria, all of the coatings evaluated in this test are exhibiting an acceptable performance when evaluated according to ANSI N101.2-1972, Section 4.5.

PROCEDURE:

1) Test Coupons

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

2) Systems Tested

Systems Tested	Theoretical Dry Film Thickness*
1. 1c Carbo Zinc 11	1.0-1.5 mils
1c Phenoline 305 Finish	3.0 mils
2. 1c Carbo Zinc 11	1.0-1.5 mils
1c Phenoline 305 Finish	6.0 mils
3. 1c Carbo Zinc 11	1.0-1.5 mils
1c Carboline 191HB	3.0 mils
4. 1c Carbo Zinc 11	1.0-1.5 mils
1c Carboline 191HB	6.0 mils
5. 1c Carbo Zinc 11	1.0-1.5 mils
1c Phenoline 368WG	3.0 mils

*Please refer to "Results" [illegible]ed Total Dry Film Thickness.

3) Cure Schedule

Carbo Zinc 11: Overnight at high humidity.
Phenoline 305: Four days at 75°F, final cure.
Carboline 191HB: Seven days at 75°F, final cure.
Phenoline 368WG: Seven days at 75°F, final cure.

From the Carboline Research & Development Laboratory

EXPOSURE: Bechtel 1975 LOCA, Ref. CP-956

1) Water Chemistry

Demineralized water test solution containing:

0.28 Molar H_3BO_3 (3000 ppm. Boron),

0.064 Molar $Na_2S_2O_3$,

pH adjusted to 9.5 with reagent grade NaOH.

EXPOSURE: (Cont.)

2) Time-Temperature-Pressure Profile

Time Lapse	Pressure, psig	Temperature	Test Conditions
Initial	Atmospheric	70°F - 90°F	Static
0 - 10 Seconds	70 psig (Steam Blast)	300°F	Static
10 Seconds - 30 Minutes	70 psig (Dry Heat)	340°F	Static
30 Minutes - 2 Hours	70 to 30 (Wet) psig Drop at 0.1 psig/second minimum	Decrease to 250°F	Dynamic
2 Hours - 96 Hours	30 psig (Wet)	250°F	Dynamic
4 Days - 12 Days	10 psig (Hot Soak)	200°F	Static

NOTE: Panels were exposed in pairs so that one panel was suspended in the vapor phase of the chamber while the other was immersed in the liquid phase on the floor of the test chamber.

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 N101-1972 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:

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.

TESTING PROJECT: 01406
FINAL REPORT TWELVE DAYS

December 26, 1975
Page 5

GRADING
PROCEDURE: (Cont.)

(December 1974)

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 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

Coating System	Total Dry Film Thickness (Measured)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
1A)* Carbo Zinc 11 Phenoline 305	4.0 mils	10	None	10	10	Slight coating discoloration	Acceptable
1B) Carbo Zinc 11 Phenoline 305	4.0 mils	10	None	10	10	Moderate coating discoloration	Acceptable
2A)* Carbo Zinc 11 Phenoline 305	6.0 mils	10	None	10	10	Moderate coating discoloration	Acceptable
2B) Carbo Zinc 11 Phenoline 305	6.0 mils	10	None	#6F-B on one edge	10	Moderate coating discoloration	Acceptable
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)	*Panels suspended	in chamber

TESTING PROJECT: 01406
FINAL REPORT - TWELVE DAYS

December 26, 1975
Page 7

Coating System	Total Dry Film Thickness (Measured)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
3A)* Carbo Zinc 11 (1) Carboline 191HB	5.5 mils	10	None	10	10	Moderate coating discoloration	Acceptable
4A)* Carbo Zinc 11 Carboline 191HB	8.2 mils	10	None	10	10	Moderate coating discoloration	Acceptable
4B) Carbo Zinc 11 Carboline 191HB	6.0 mils	10	None	10	10	Moderate coating discoloration	Acceptable
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8 MD	#8 (Light)	*Panels suspended in chamber (1)no duplicate panel	

TESTING PROJECT: 01406
FINAL REPORT - TWELVE DAYS

December 26, 1975
Page 8

Coating System	Total Dry Film Thickness (Measured)	Flaking	Delamination or Peeling	Blistering	Chalking	Other Performance Characteristics	Performance Evaluation
5A)* Carbo Zinc 11 Phenoline 368WG	4.5 mils	10	None	10	#9 (Very light)	Moderate coating discoloration	Acceptable
5B) Carbo Zinc 11 Phenoline 368WG	4.7 mils	10	None	10	#9 (Very light)	Moderate coating discoloration	Acceptable
Perfect Performance per ANSI N101.2-1975		10	None	#4F to #8MD	#8 (Light)	*Panels suspended in chamber	

John F. Montle
Vice-President
Research & Development

Patrick D. Fisher
Developmental Engineer
Testing Department

xc: SLL/HDT/JFM/EWS/JDB/JDP/SLS/DRL/CJW/RJT/LAB GROUP LEADERS

ATTACHMENT 2

SAMPLE TEST REPORT - AMERON COMPANY

AMERON
PROTECTIVE COATINGS DIVISION

TECHNICAL SERVICE - BREA LABORATORY

C/R II 71 - (4)
71 - (6)
90 - (4)
90 - (6)
III DBA Testing

LABORATORY SERVICE REQUEST
NO. 2537

FINAL REPORT

Date Initiated: 8/29/78
Date Completed: 9/6/78

Subject: DBA Testing of Amercoat 71/90 when applied at high dry film thickness

Requested by: H. H. Kline

Reference: Verbal request. Waterford 3/Peden Steel
Laboratory Workbook #718 Test #49

INTRODUCTION

Steel structures were shop primed with Amercoat 71 and shipped to the job site. Inspection showed most of the primed steel had a thickness of more than 5 mils with some areas showing a dry film thickness up to 15 mils. To determine if this excess in thickness would affect the performance of the system, we ran an in-house DBA test following ANSI PWR curve on samples prepared with a thickness range of 9 to 20 mils for Amercoat 71 and 5 to 11 mils for Amercoat 90.

CONCLUSIONS

All of the panels passed the DBA test conducted according to ANSI N 101.2 to meet the PWR conditions.

METHODS AND RESULTS

2" x 4" x 1/4" ASTM A-36 Steel panels were used. They were cured in the laboratory for 7 days prior to testing. Test was performed following ANSI N101.2 PWR curve as closely as possible. The actual conditions of the test, information on panel preparation and the results are on attached sheets.

Batch numbers used were: Amercoat 71 1-806329 and 1-807304
Amercoat 90 1-701068 and 1-701069

Written by: G. A. Valdez

Approved by: J. I. Richardson

Distribution: H. H. K.

Manufacturer: Ameron Protective Coatings Division, Brea

Ameron Coatings Lab

Date: September 5, 1978

Table 1. DBA Solution Composition.

0.28 M Boric Acid (3,000 ppm boron)

0.064 M Sodium Thiosulfate

Adjusted to pH 9.5 with sodium hydroxide.

Table 2. DBA Test Conditions

Time	Temperature (°F)	Pressure (psig)	Comments
.0	165	0	
10 sec.	285	59	
10 min.	281	60	
75 min.	drop to 265	48	Gradual drop.
80 min.	drop to 220	drop to 42	sudden drop
82 min.	back to 265	back to 48	
from 82 to 170 min.	drop to 240	drop to 23	Gradual drop
from 170 min. to 24 hrs.	160 to 220	16 to 24	
from 24 hrs. to 4 days	170 to 180	from 18 drop to 8	

End of test

Test Report No. 2537

Approved S Valle

Manufacturer Ameron Protective
Coatings Division, Brea

Ameron Coating Lab
Date September 5, 1978

SYSTEM IDENTIFICATION: XX STEEL ____ CONCRETE BLOCK

Amercoat 71 at High Thicknesses topcoated with Amercoat 90

DBA TEST RESULTS:

ANSI PWR; 4 days
Laboratory Workbook 718 - Test #49

SAMPLE No.	DFT (mils)	DBA PHASE	COMMENTS
2-1 2537	Front: 18/7 Back: 9.5/9	Vapor	Coatings intact - No defects
2-2 2537	Front: 18/7 Back: 9/10	Immersed	Coatings intact - No defects
2-5 2537	Front: 18/11 Back: 10/6	Vapor	Coatings intact - No defects
2-6 2537	Front: 18/11 Back: 10/6	Immersed	Coatings intact - No defects

Approved S Valdez

Test Report No. 2537

DESIGN BASIS ACCIDENT (DBA)

TEST PANEL PREPARATION DATA

1. PRODUCT TO BE TESTED Amercoat 71/Amercoat 90

2. TYPE SUBSTRATE: ASTM A-36 Steel SIZE 2" x 4" x 1/4"

3. SURFACE PREPARATION (describe): Gritblasted to SSPC-SP10 minimum, with G-40 Steel Grit; Profile 2-3 G/S 76 Keane-Tator Profile Comparator

4. PRODUCT DATA: SAMPLE No.(s) 2-6 2437

5. DATE AND TIME CURING COMPOUND OR PRIMER APPLIED

SIDE	COAT	PRODUCT	PRODUCT CODES	BATCH #	APPLICATION METHOD	CONDITIONS R/M(°F)	%R.H.	THICKNESS (ins.)	TIME & DATE APPLIED
F	1	Amercoat	71	1-806329 1-807304	Suction Gun	78	59	0.018"	8-18-78 4:10 PM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.011"	8-22-78 2:45 PM
B	1	Amercoat	71	1-806329 1-807304	Suction Gun	71	68	0.010"	8-21-78 10:10 AM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.006"	8-22-78 2:45 PM

F = Front B = Back

6. CURING CONDITIONS: AMBIENT TEMP 70 ± 10 °F REL. HUMIDITY 50 ± 10 %

MINIMUM CURE 7 DAYS.

7. TEST PROCEDURE: ANSI N101.2 PWR Curve

8. TESTING PERFORMED BY: Brea's Laboratory DATE SUBMITTED N/A

S Valdez

TEST REPORT No. 2537

DESIGN BASIS ACCIDENT (DBA)

TEST PANEL PREPARATION DATA

1. PRODUCT TO BE TESTED Amercoat 71/Amercoat 90

2. TYPE SUBSTRATE: ASTM A-36 Steel SIZE 2" x 4" x 1/4"

3. SURFACE PREPARATION (describe): Gritblasted to SSPC-SP10 minimum, with G-40 Steel Grit; Profile 2-3 G/S 76 Keane-Tator Profile Comparator

4. PRODUCT DATA: SAMPLE No.(s) 2-2 2537

5. DATE AND TIME CURING COMPOUND OR PRIMER APPLIED

SIDE	COAT	PRODUCT	PRODUCT CODES	BATCH #	APPLICATION METHOD	CONDITIONS R/M(°F)	%R.H.	THICKNESS (ins.)	TIME & DAT APPLIED
F	1	Amercoat	71	1-806329 1-807304	Suction Gun	78	59	0.018"✓	8-18-78 4:10 PM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.007"	8-22-78 2:45 PM
B	1	Amercoat	71	1-806329 1-807304	Suction Gun	71	68	0.009"✓	8-21-78 10:10 AM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.010"	8-22-78 2:45 PM

F = Front B = Back

6. CURING CONDITIONS: AMBIENT TEMP 70 ± 10 °F REL. HUMIDITY 50 ± 10 %

MINIMUM CURE 7 DAYS.

7. TEST PROCEDURE: ANSI N101.2 PWR Curve

8. TESTING PERFORMED BY: Brea's Laboratory DATE SUBMITTED N/A

G Valdez

TEST REPORT No. 2537

DESIGN BASIS ACCIDENT (DBA)

TEST PANEL PREPARATION DATA

1. PRODUCT TO BE TESTED Amercoat 71/Amercoat 90
2. TYPE SUBSTRATE: ASTM A-36 Steel SIZE 2" x 4" x 1/4"
3. SURFACE PREPARATION (describe): Gritblasted to SSPC-SP10 minimum, with G-40 Steel Grit; Profile 2-3 G/S 76 Keane-Tator Profile Comparator
4. PRODUCT DATA: SAMPLE No.(s) 2-5 2437
5. DATE AND TIME CURING COMPOUND OR PRIMER APPLIED

SIDE	COAT.	PRODUCT	PRODUCT CODES	BATCH #	APPLICATION METHOD	CONDITIONS R/M(°F)	%R.H.	THICKNESS (ins.)	TIME & DAT APPLIED
F	1	Amercoat	71	1-806329 1-807304	Suction Gun	78	59	0.018" ✓	8-18-78 4:10 PM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.011"	8-22-78 2:45 PM
B	1	Amercoat	71	1-806329 1-807304	Suction Gun	71	68	0.010" ✓	8-21-78 10:10 AM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.006"	8-22-78 2:45 PM

F = Front B = Back

6. CURING CONDITIONS: AMBIENT TEMP 70 ± 10 °F REL. HUMIDITY 50 ± 10 %

   MINIMUM CURE 7 DAYS.
7. TEST PROCEDURE: ANSI N101.2 PWR Curve
8. TESTING PERFORMED BY: Brea's Laboratory DATE SUBMITTED N/A

DValdez

TEST REPORT No. 2537

DESIGN BASIS ACCIDENT (DBA)

TEST PANEL PREPARATION DATA

1. PRODUCT TO BE TESTED Amercoat 71/Amercoat 90

2. TYPE SUBSTRATE: ASTM A-36 Steel SIZE 2" x 4" x 1/4"

3. SURFACE PREPARATION (describe): Gritblasted to SSPC-SP10 minimum, with G-40 Steel Grit; Profile 2-3 G/S 76 Keane-Tator Profile Comparator

4. PRODUCT DATA: SAMPLE No.(s) 2-1 2537

5. DATE AND TIME CURING COMPOUND OR PRIMER APPLIED

SIDE	COAT	PRODUCT	PRODUCT CODES	BATCH #	APPLICATION METHOD	CONDITIONS R/M(°F)	%R.H.	THICKNESS (ins.)	TIME & DA[TE] APPLIE[D]
F	1	Amercoat	71	1-806329 1-807304	Suction Gun	78	59	0.018" ✓	8-18-78 4:10 PM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.007"	8-22-78 2:45 PM
B	1	Amercoat	71	1-806329 1-807304	Suction Gun	71	68	0.0095 ✓	8-21-78 10:10 AM
	2	Amercoat	90	1-701068 1-701069	Suction Gun	76	55	0.009"	8-22-78 2:45 PM

F = Front B = Back

6. CURING CONDITIONS: AMBIENT TEMP 70 ± 10 °F REL. HUMIDITY 50 ± 10 %

MINIMUM CURE 7 DAYS.

7. TEST PROCEDURE: ANSI N101.2 PWR Curve

8. TESTING PERFORMED BY: Brea's Laboratory DATE SUBMITTED N/A

G. Valdez

TEST REPORT No. 2537

ATTACHMENT 3

AMERON LETTER

RECEIVED

MAR 1 8 1985

CORROSION DEPT.

AMERON ELECTRONIC MAIL SYSTEM

Printed on : 02-19-85

FROM : HARLAN.KLINE AT : 08:20:56 19 FEB 1985 SYS TIME
TO : W.F. GUNDAKER (DESTINATION: 25422365)

SUBJECT : DBA QUAL TESTING KEYWORD :

FROM: HARLAN KLINE/AMERON-PCD

TO: W. F. GUNDAKER/EBASCO, NY
JORAM LICHTENSTEIN/EBASCO, HOUSTON

PLEASE REVIEW THE FOLLOWING, CONCERNING D-6/90, DEZ/90 AND 71/90 IN CONTAINMENT THAT WE HAVE BEEN DISCUSSING RECENTLY.

NUCLEAR DBA QUALIFICATION TESTING WITH OR WITHOUT PRE-IRRADIATION AT LEVELS OF 2X10 -8 OR 1X10 -9 RADS SHOWS NO DIFFERENCE IN RESULTS AT INITIAL DBA TIME/TEMPERATURE CONDITIONS OF 1/2 HOUR/335 F OR 6 HOUR/340 F FOR THE FOLLOWING COATING SYSTEMS OVER ABRASIVE BLASTED STEEL:

DIMETCOTE 6/AMERCOAT 90
DIMETCOTE EZ/AMERCOAT 90
AMERCOAT 71/AMERCOAT 90

THE RESULTS WERE ''NO COATING DEFECTS'' IN ANY OF THE TEST PANELS IN THESE TESTS CONDUCTED BY OAKRIDGE NATIONAL LABORATORY AS PART OF OUR COATING QUALIFICATION TESTING TO ANSI AND PROJECT REQUIREMENTS.

THE INFLUENCE OF PRE-IRRADIATION ON THE CAPABILITY OF COATING SYSTEM TO WITHSTAND DBA ENVIRONMENTS MAY BE VIEWED AS HAVING ADDED STRESS AND THIS MAY BE THE CASE WITH SOME COATINGS. HOWEVER, PRE-IRRADIATION IS NOT DEMONSTRATED TO HAVE ANY INFLUENCE ON DIMETCOTE 6/AMERCOAT 90, DIMETCOTE EZ/AMERCOAT 90 OR AMERCOAT 71/ AMERCOAT 90 AS DESCRIBED ABOVE.

THE PRE-IRRADIATION EXPOSURE USED IN QUALIFICATION TESTING IS THE TOTAL RADIATION EXPECTED OVER THE NORMAL 40 YEAR DESIGN LIFE OF THE PLANT AND IS ACCOMPLISHED AT AN EXPOSURE RATE AROUND 1X10 -7 RADS PER HOUR, I.E., 4 DAYS FOR 1X10 -9 RADS TOTAL. THIS IS AN ACCELERATED EXPOSURE, MUCH MORE SEVERE THAN WILL BE ENCOUNTERED IN ACTUAL SERVICE. THIS ACCELERATED EXPOSURE SHOWED NO INFLUENCE ON THE DIMETCOTE 6/AMERCOAT 90, DIMETCOTE EZ/AMERCOAT 90 OR AMERCOAT 71/ AMERCOAT 90 IN THE DBA QUALIFICATION TESTING.

DBA TESTING WITH AND WITHOUT PRE-IRRADIATION AT 2-3X10 -8 RADS OVER A POWER TOOL CLEANED SURFACE PREPARED WITH 3M CLEAN N STRIP SHOWED ONLY MINOR INTACT BLISTERING OF FEW #6 OR #8 ON ONE SIDE OF ONE

ATCRON ELECTRONIC MAIL SYSTEM

Mail for : Printed on : 02-19-85

file

PANEL PRE-IRRADIATED FOR AMERCOAT 90 OR AMERCOAT 71/AMERCOAT 90. THIS DEMONSTRATES NO DELAMINATION TYPE FAILURE OVER SURFACES HAVING LESS THAN THE ABRASIVE BLAST CLEANING LEVEL OF PREPARATION.

THERE HAS BEEN NO DELAMINATION TYPE FAILURE IN SERVICE FOR DIMETCOTE 6/AMERCOAT 90, DIMETCOTE EZ/AMERCOAT 90 OR AMERCOAT 71/AMERCOAT 90 REPORTED WHERE THESE COATINGS HAVE BEEN APPLIED IN NUCLEAR POWER PLANTS AT RECOMMENDED DRY FILM THICKNESS. THERE IS ONE INSTANCE WHERE AMERCOAT 90 WAS APPLIED AT UP TO 40 MILS DFT OVER DIMETCOTE 6 WHICH DID SHOW SOME VISIBLE CRACKING AND DELAMINATION REQUIRING REPAIR. A DBA TEST CONDUCTED ON EXCESSIVE AMERCOAT 90 DRY FILM THICKNESS UP TO 40 MILS DFT SHOWED INDICATIONS THAT PRE-IRRADIATION DID INFLUENCE DBA TEST RESULTS. HOWEVER, THE COATING SYSTEM REMAINED INTACT, DID NOT DELAMINATE AND ONLY SHOWED #2 TO #6 BLISTERS OR A FEW SMALL CRACKS.

THIS DEMONSTRATES THAT THE INFLUENCE OF PRE-IRRADIATION AT ACCELERATED CONDITIONS ON AMERCOAT 90 IN A DBA ENVIRONMENT IS NOT SUFFICIENT TO CAUSE DELAMINATION OF THE COATING EVEN WHEN APPLIED AT EXCESSIVELY HIGH OR DRY FILM THICKNESS.

PLEASE CALL ME (714/529-1951 X-362) OR TELEX 655342
THANK YOU.

HARLAN

Copies : HARLAN KLINE SHARON HEINZ

ATTACHMENT 4

TELECON WITH MR J MONTLE

11046/5-74

RECORD OF TELEPHONE CONVERSATION

DATE March 22, 1985

TO FILE
NAME/FILE NO.

FROM J LICHTENSTEIN

CLIENT/PROJECT WATERFORD NGS

SUBJECT PROTECTIVE COATING MODE OF FAILURE

CHARGE: DEPT. NO. 647/570 CLIENT SYMBOL LOU OFS NO. 2864.237

DISCUSSION WITH - J Montle, Vice President, Carboline Co., (314) 644-1000

I asked John what the mode of failure and delamination would be on the Class I coating used at the subject plant.

He stated that the failure will be by blistering. In the event that actual delamination or pealing occures, the paint chips will be very small, in the range of 1/16 to 1/2 inch. His experience through observing many test panels coated with an inorganic zinc and epoxy or a two coat epoxy system is that the failures are small paint chips rather than sheets of materials.

COMMENTS

BY J Lichtenstein Mgr. Corr. Engr. 647
NAME TITLE DEPT. NO.

CC: W F Gundaker
J S Semple, Jr.

ATTACHMENT 5

TELECON WITH MR R BROOKSBANK

11846/8-74

RECORD OF TELEPHONE CONVERSATION

DATE March 22, 19[illegible]

TO FILE
NAME/FILE NO.

FROM J LICHTENSTEIN JL

CLIENT/PROJECT WATERFORD NGS

SUBJECT PROTECTIVE COATING MODE OF FAILURE

CHARGE: DEPT. NO. 647/570 CLIENT SYMBOL LOU OFS NO. 2864.237

DISCUSSION WITH - Rick Brooksbank, (615) 574-4885

I talked with Rick at the Oak Ridge National Testing Laboratory regarding the typical mode of failure of coating system similar to the one used at Waterford.

He said that the failure are usually intact blistering. If delamination actually occur it is predominantly in the form of small paint chips.

COMMENTS

CC: W F Gundaker
J S Semple, Jr.

BY J Lichtenstein Mgr. Corr. Engr. 647
NAME TITLE DEPT. NO.