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MIDDLE SOUTH UTILITIES SYSTEM

February 27, 1985

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Director of Nuclear Reactor Regulation
Attention: Mr. G.W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: Waterford SES Unit 3
Docket No. 50-382
LP&L Report on the Evaluation of Containment Coatings

REFERENCES: 1) LP&L Letter, W3P85-0130, dated January 17, 1985

2) Texas Utilities Generating Company (TUGCO) Report, Revision 1, Titled, "Evaluation of Paint and Insulation Debris Effects on Containment Emergency Sump Performance", dated October 1984

Dear Sir:

Louisiana Power & Light on January 17, 1985 submitted to the NRC the subject report on the evaluation of containment coatings. Subsequently, a meeting was held, at the request of the NRC, on February 11, 1985 among LP&L, Ebasco, and the NRC to review the subject report.

During the meeting, extensive discussions were held relative to the methodologies, assumptions, and other evaluations contained in the report. The purpose of this letter is therefore to present LP&L's position on the various issues or questions that were raised in the meeting.

LP&L's position remains that paint coatings in the Containment are substantially qualified, and there would be no adverse impact on post accident fluid systems in the event of a postulated Design Basis Accident (DBA). Secondly, LP&L and Ebasco presented a highly conservative analysis which demonstrated, based on calculational methods and the postulated failure of all paint coatings, except insulated piping and painted concrete, that the performance of the SIS Sump and post accident fluid systems would not be unacceptably degraded. Finally, other issues or questions raised by the NRC have been evaluated, and while LP&L intends to perform additional confirmatory analyses, as discussed in Section VII of this letter, LP&L is convinced that the conclusions in the report remain valid.

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The issues or information addressed in this letter are the following:

- I Qualification of Paint
- II Analysis
- III NPSH Available To HPSI and CS Pumps
- IV Impact of Paint on TSP Baskets
- V Jet Impingement
- VI Postulated Ingestion of Paint Fragments
- VII Testing and Surveillance
- VIII Conclusions

A discussion of these subjects follows in the stated order.

I. Qualification of Paint

A. 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 LP&L response to NRC Question 281.2 describe LP&L's program for protective coatings. The NRC reviewed this program and concluded in SSER 1 that the protective coating systems and the applications were acceptable and met the requirements of Appendix B to 10CFR50.

B. Coatings DBA Tested and Qualified

LP&L conducted an evaluation of the paint coatings inside containment, reference FSAR Section 6.1.2.1, and LP&L determined that paint coatings applied to significant surface areas inside the containment are in substantial compliance with ANSI N102.1, 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 Standards 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 approximately 91,900 ft^2 of steel containment vessel plates and 269,950 ft^2 of uninsulated piping and structural main equipment, reference FSAR Table 6.1-3, was tested and qualified under DBA conditions.

C. Coatings Not DBA Tested and Not Qualified

The only source of unqualified paint coatings is due to 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, reference LP&L response to NRC Question 281.2.

D. 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 100% 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.

Further, an in-situ DBA test was conducted. Three containment liner surface areas were selected. Steam was applied on each area via the 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.

II. Analysis

The paint coating analysis performed by Ebasco was a highly conservative analysis, and the analysis demonstrated that there would be no adverse effect on post accident fluid systems. The assumptions and derivations for generalized motion and transport of paint particles that were developed by Ebasco in the Texas Utilities Generating Company Report (TUGCO), reference two (2), were utilized. The assumptions and the methodologies employed constituted gross conservatisms. The following is a summary of the analysis.

A. General

The analysis assumed that, except for insulated piping and painted concrete, all paint coatings inside Containment, regardless of qualification, failed. The analysis then assumed that all the failed paint would fall to the bottom of the containment and thereby be available for transport to the SIS Sump region. In actuality, a portion of the paint would remain on higher levels. Transport of the paint was analyzed in two parts, that paint that falls far from the SIS Sump (far field) and that paint that falls closer than a perimeter of 3.42 feet from the SIS Sump (near field).

B. Far Field

It was determined that paint falling far from the SIS Sump could physically only reach the SIS Sump by traveling through four critical regions because of the structural configuration of the Containment. The water velocities in each of these four critical regions were then calculated by another conservative assumption that the total flow of the HPSI pumps would pass through each critical region, i.e., the break was assumed to be near the critical region and then the transport of paint fragments to the SIS Sump was analyzed. The analysis determined that the velocity in only one critical region was marginally sufficient, by 0.071 ft/sec, to transport paint from a quadrant of the containment to the quadrant where the SIS Sump was located. However, based on the water velocity at the SIS Sump screen documented in FSAR Section 6.2.2.2.2.1, a water drift velocity in the SIS Sump region of 0.0227 ft/sec was determined which is insufficient to transport the paint particles fragments which were postulated to fail. Therefore, the analysis thus determined that paint falling outside a perimeter of 3.42 feet from the SIS Sump, which would constitute the majority of the paint assumed to fail (approximately 99.5%), would settle to the bottom of the containment and would not clog the SIS Sump screens.

C. Near Field

The transport of paint fragments near the SIS Sump was modeled by defining an inclusion area, a rectangular region bounded by perimeters of 2.04 and 3.42 feet from the SIS Sump, around the SIS Sump whereby paint fragments could reach the SIS Sump vertical screens. The inclusion area around the SIS Sump was determined by applying the transport theory utilized in the TUGCO report. The time required for a paint fragment to settle to the containment concrete floor was determined. By using the local velocities of the water near the SIS Sump, documented in FSAR Section 6.2.2.2.2.1, the minimum and maximum distances that the paint fragment could reach the SIS Sump vertical screens was determined, or an inclusion area, since paint fragments farther than a distance of 3.42 feet would settle to the concrete floor and paint fragments closer than a distance of 2.04 feet would settle on the SIS Sump horizontal screen. The SIS Sump horizontal screen was assumed to be clogged due to the assumed failure of the paint coatings.

Various conservatisms were applied in defining the inclusion area. A paint fragment size of 0.078 inches was assumed as that size was the minimum size that would cause blockage of the SIS Sump screens. The maximum water level or the maximum time required for the paint fragment to reach the containment concrete floor was utilized. The maximum drag coefficient was assumed to act on the paint fragment to maximize the paint fragment settling time. A horizontal orientation of the paint fragment was assumed to maximize the paint fragment settling time. All paint fragments falling in the inclusion area were modeled as hitting the water surface and stopping, rather than intruding into the water surface, thus again maximizing the settling time of the paint fragment.

All paint directly above the inclusion area was assumed to fall in the inclusion area. A total of 1745 ft^2 of paint was assumed to fall in the inclusion area. As a benchmark only about 13,950 ft^2 of the containment paint is not qualified. Since approximately 99.5% of the unqualified paint would fall in the far field regions of the containment, only about 0.5% of the unqualified paint or about 70 ft^2 (compared to 1745 ft^2 assumed in the analysis) could be available to fall in the near field region. 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.

The analysis applied still another highly conservative assumption, that each and every paint fragment of 0.078 inches would align itself one next to the other, with no overlap, on the SIS Sump vertical screens. No credit was taken for the horizontal screen, i.e., it was assumed to be blocked. The analysis determined that using the foregoing highly conservative methodology and analysis that about 34.5% of the vertical screen area would not be blocked. This unclogged area of the SIS Sump vertical screens is more than sufficient to prevent pump vortexing and to provide for adequate NPSH to ensure proper operation of HPSI and CS pumps.

III. 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 ensure proper operation of the HPSI and CS pumps. These evaluations are documented in the responses to NRC Questions 211.64 and 211.10 and FSAR Sections 6.2.2.3.2.1 and 6.3.2.2.2.3. A basis for the NPSH information documented in the foregoing FSAR 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 Unit 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% 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% screen blockage For post LOCA recirculation mode, only the operations of the containment spray pump and the high pressure safety injection 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% 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% blocked screen and 3140 GPM flow. The screen loss with 11,780 GPM flow and 90% screen blockage is 0.317 ft.

The NPSH required and NPSH available are shown here, reference FSAR Sections 6.2.2.3.2.1 and 6.3.2.2.2.3, for Containment Spray (CS) and High Pressure Safety Injection (HPSI) pumps:

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

The NPSH margins available for CS and HPSI are 94.8% and 40.8%. Thus, the calculated NPSH screen losses of 0.0225 ft. and 0.317 ft.. represent an insignificant 0.2% and 2% respectively of the NPSH required for CS and even less for HPSI. Therefore, 90% blockage of the SIS Sump screen has a minimal effect on pump NPSH.

IV. Impact of Paint on Trisodium Phosphate Dodecahydrate (TSP) Baskets

Postulated paint blockage of the TSP basket is not expected to have any adverse effect since the TSP is expected to be substantially dissolve 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 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 (CE) 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 area to volume ratio and lower solubility than the bulk chemical, so 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 is almost instantaneous.

FSAR Section 6.1.3 indicates that containment spray 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 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 pH 7, the relative times involved would not decrease the effectiveness of the pH control system.

V. 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 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 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.

VI. Postulated Ingestion of Paint Fragments

LP&L also evaluated the potential adverse effects of the postulated ingestion of paint fragments into the Reactor Coolant System (RCS) and the reactor core. The evaluation determined that there is no adverse effect on post accident fluid systems as a result of the postulated ingestion of paint coating fragments into the RCS and the reactor core.

Laboratory tests conducted by Paint Manufacturers and information provided by Paint Manufacturers indicate that the failure mode of the primer and topcoat coating combinations applied at Waterford Unit 3 is blistering or cracking, i.e. the flaking or peeling mode. Flaking or peeling is the failure of the paint coating film by flakes of small particles, 1/8 inch to 1 inch particles, reference TUGCO report. Thus, any postulated failure of paint coatings would be large particles in the range of 1/8 inch to 1 inch in size rather than the small particle size (0.078 inches) assumed in the sump blockage analysis. The amount of paint available for ingestion by the RCS and the reactor core was determined by assuming that the paint coatings failed as fragment 0.078 inches in size and could pass through the SIS Sump vertical screens. This assumption thus provided a conservative basis for the ingestion evaluation.

As stated previously, the SIS Sump will not pass any paint coating particles greater than 0.078 inches in size. Combustion Engineering (CE) has confirmed that particulate matter 0.090 inches in diameter will have no detrimental effect on the operation of the HPSI pumps. CE has also confirmed that particulate matter 0.250 inches in diameter will have no detrimental effect on operation of the HPSI pumps. The containment spray nozzle is not susceptible to blockage since the nozzle throat diameter is much greater than the postulated paint coating particle assumed to ingested, i.e. 0.375" is much greater than 0.078". Other various types of equipment, such as valves, pumps, heat exchangers, orifice flow elements, and vortex breakers were also evaluated, and it was determined that paint coating particles 0.078 inches in diameter assumed to be ingested would have no detrimental effect.

The effect of the postulated ingestion of paint coating into the reactor core was also evaluated, and the evaluation determined that there is no detrimental effect on the core. Any paint coating blockage assumed to occur in the core would have the greatest propensity for occurring 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 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.

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 has been conducted to determine the effects of fuel assembly coolant flow maldistribution during normal reactor operation, reference FSAR Section 4.2.3.2.16. 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 W-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 W-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.

VII. Testing and Surveillance

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

As stated in Section I of this letter, the containment coatings are substantially qualified. Previously identified coating deficiencies have been identified, and corrective measures have been taken, including 100% 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 I of this letter, 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.

VIII. Conclusions

LP&L strongly believes that by virtue of the conservative analyses and the evaluations presented in the subject report and the information presented herein that the highest degree of assurance has been provided substantiating the integrity of the Waterford Unit 3 paint coatings and the acceptable performance of post accident fluid systems. Accordingly, LP&L recommends that the license condition on paint coatings be rescinded for Waterford Unit 3.

Notwithstanding the foregoing position, LP&L intends to implement additional confirmatory measures. LP&L will perform additional confirmatory evaluations which include a three dimensional analysis of the near field effect of paint coating fragments on the SIS Sump and a confirmatory evaluation of the particle size failure characteristics of the paint coatings used at Waterford Unit 3. The results of the analysis and confirmatory evaluation are expected to be completed by 1 April 1985. The NRC will be notified by letter should the analysis or confirmatory evaluation significantly impact the conclusions stated in the subject report or in this letter. Finally, LP&L will perform a thorough and careful visual inspection of all affected areas of the containment using optical aids, such as binoculars to detect current or incipient failures of coated surfaces. The visual inspections will be implemented at each refueling outage, and the results of the visual inspections will be reviewed and documented using currently approved LP&L procedures. LP&L will perform additional inspections, evaluations, or testing as appropriate in the unlikely event that the visual inspection indicates significant coating failure or significant degradation. Repair of all deficient areas would be performed in accordance with approved specifications and procedures pursuant to ANSI N101.2, N5.12, and N101.4. LP&L believes these confirmatory actions assure reasonable safety.

Please feel free to contact me or Robert J. Murillo, Safety and Environmental Licensing Unit Coordinator, should you have any questions concerning this letter.

Very truly yours,

KW Cook

K. W. Cook
Nuclear Support & Licensing Manager

KWC/RJM/ch

cc: E.L. Blake, W.M. Stevenson, R.D. Martin, J. Wilson, G.L. Constable