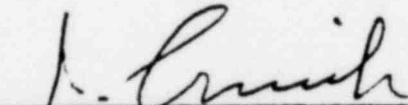


LOUISIANA POWER & LIGHT COMPANY

WATERFORD SES UNIT NO 3

FINAL REPORT OF
SIGNIFICANT CONSTRUCTION DEFICIENCY NUMBER 13

REACTOR CONTAINMENT BUILDING DOME CONCRETE



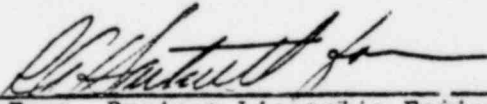
J Conich, Site Manager



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April 8, 1980

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SECTION I - SUMMARY

During the placement of concrete for Reactor Containment Building dome parapet wall placement 521-1B, improper consolidation of concrete in the lower portion of the wall occurred. Proper consolidation of the concrete as required per Fegles Power Services' Procedure CP-303-3 and Ebasco Concrete Masonry Specification LOU 1564.472 was not achieved. Upon removal of the exterior wall forms, numerous honeycomb and rock pockets randomly distributed in the lower portion of the wall were evident. Fegles Power Services initiated Nonconformance Report W3-1576 describing these defects. The concrete defects were primarily due to improper, random vibration during the concrete placement.

SECTION II - DESCRIPTION OF DEFICIENCY

The Reactor Containment Building dome placement 521-1B is a curved reinforced concrete structure 118'-7" long, 3'-0" thick, and 11'-6" in height. The placement is between elevation +179.00' to +190.50' with a haunch for the initial section of the dome concrete. The concrete placement commenced at 6:15 a.m. on August 8, 1979. At approximately 10:00 a.m., the concrete pump line plugged and the placement continued by placing the concrete with the use of crane and buckets. The concrete vibrators in use were inadequate in both size and number to provide proper vibration of the concrete. In some situations, concrete was allowed to fall without the use of the tremies in excess of the specified limit of five (5) feet. Concrete was also allowed to dry on the reinforcing steel and measures taken to remove it were inadequate.

At approximately 12:00 (noon), additional vibrators, men, and wire brushes were added to the existing placement crews to insure proper vibration of the concrete and cleaning of the reinforcing steel of dry concrete. The placement proceeded without further incident and was completed by 6:00 p.m.

On August 13, 1979, the outside wall forms were removed. Numerous surface honeycomb and voids were encountered in the lower portion of the placement with some of these areas extending past the embedded reinforcing steel. This indicated that consolidation of the concrete as required by Fegles Procedure CP-303-3 and Ebasco Specification LOU 1564.472 was not achieved.

SECTION III - ANALYSIS OF THE SAFETY IMPLICATIONS

Had this deficiency been left uncorrected, this noncompliance with concrete placement practices would compromise the ability of the Reactor Containment Building to satisfy some of the design bases loads and loading combinations as set forth in Sub-section 3.8.4 of the Final Safety Analysis Report.

SECTION IV - CORRECTIVE ACTION AND INVESTIGATION/EVALUATION/REPAIR

A) Corrective Action:

The immediate corrective action taken during the placement of the dome south parapet wall after the discovery of the inadequate concrete consolidation was to add an adequate number of vibrators, laborers, and inspectors to ensure proper placement of the concrete. Tremies were replaced back onto the placement to ensure that the concrete drop was within the specified limit of five (5) feet. Additional laborers with wire brushes were assigned to remove dried concrete from the resteel. After the removal of the wall forms, Fegles initiated Nonconformance Report W3-1576 on August 13, 1979.

Corrective action implemented to prevent the recurrence of the problems encountered was the issuance of a Stop Work Order on any additional dome concrete placement by Fegles Power Services until the following corrective actions were completed:

1. Fegles shall provide a qualified job Superintendent.
2. Fegles shall assign an experienced placement supervisor who has ultimate charge at the placement to direct the overall placement. Additionally, one general foreman shall be assigned for each separate placement (each side).
3. Fegles personnel shall be indoctrinated and trained to the requirements of Ebasco Specification LOU 1564.472 for concrete placement with particular attention to lift height restrictions, vibration requirements, cold joint determination and subsequent action requirements. This training shall take place at the Waterford Site. LP&L and Ebasco shall review the plans for this training and shall be notified when the training classes will take place so that the training may be witnessed by LP&L and Ebasco. Fegles personnel who shall be trained shall include the following:
 - a. Project Superintendent
 - b. Concrete Supervisors
 - c. Foreman
 - d. QC Personnel

Vibrator operators shall be trained in the use of vibrators and the proper method of vibration.

4. A third concrete pump shall be supplied as backup.
5. Gas driven generators shall be provided as backup for vibrators.
6. Larger vibrators shall be provided.

7. A "bull" hose and air manifold shall be set up to supply the dome area and the pneumatic vibrators which shall be available.
8. More lights shall be used to light the dome.
9. A sufficient number of trained craft personnel shall be available to adequately place concrete, vibrate concrete, and to clean exposed resteel and forms of concrete spillage.
10. The concrete lines shall be modified to eliminate severe bends.
11. Adequate concrete buckets shall be supplied for backup.
12. Four concrete inspectors shall be available. At least two of the inspectors shall be certified Level II concrete inspectors. The remaining inspectors shall at least be certified as Level I concrete inspectors.
13. A pre-placement meeting shall be conducted at least 48 hours prior to placement with Fegles, Ebasco, and LP&L in attendance, to discuss in detail the plans for concrete placement.
14. LP&L QA will be notified at least 24 hours prior to scheduled placement commencement so that LP&L can conduct a pre-placement inspection and to verify that all of the above (Items 1 through 13) have been accomplished.

All corrective action items listed above were accomplished, the Stop Work Order was rescinded and concrete placement for the Reactor Building Dome resumed.

B) Investigation/Evaluation/Repair

Investigations/Evaluations

Investigation of the defects in dome concrete placement 521-1B was in a four phase program of: (1) surface chipping to sound concrete, (2) microseismic testing (Pulse Echo Method), (3) core drilling and (4) chipping of exploratory openings.

Findings from the investigation are:

- a) All surface defects were located in the lower half of the wall and mostly in the eastern section. The overall defective area was estimated to be less than 10% of the wall surface.

The inside surface defects were in general superficial, i.e. not deeper than two (2) inches. In small local areas approximately two foot square the defect went beyond the surface reinforcement.

The outside surface defects were relatively deeper as compared with those of inside surface. Nearly half of the defects went beyond the surface reinforcement. The depth of defective concrete was approximately nine (9) inches at the maximum, and less than three (3) inches in average. The difference in the depth of defective concrete is possibly due to the facts that there are three layers of rebars near the outside surface and only one layer of rebars near the inside surface, and this has made it more difficult for the concrete to properly reach to the outside surface.

It is determined according to the above that the surface defects are superficial in their penetration, and the defects from both inside and outside surfaces are not interconnected through the three (3) foot wall.

- b) A total of approximately 600 pulse echo tests had been performed according to a preplanned grid system laid on 2 foot centers. Where tests could not be performed due to surface roughness, the grid system was locally modified for proper coverage. Where clear internal reflects were found, additional test points were selected.

A majority of internal reflectors which could be considered as indications of minor entrapped air voids, cold joints and cracking were obtained from tests on the outside surface. Less than 12% of the total echo tests, 71 out of 600 found internal reflectors. Only four (4) (less than 1%) of those with internal reflectors were found from tests on the inside surface, and only four (4) from tests on the top surface. These results indicated that the internal reflectors found in the horizontal tests were practically non-existent in the vertical test orientation.

According to the results of pulse echo tests, the possibility of cold joints, which was the original major concern, exists only in a few small (lateral extent less than 3 to 4 inches) areas. This finding was confirmed by the results obtained from vertical and horizontal corings and exploratory chippings. The minimum insitu concrete compressive strength is 4900 psi and well above the design strength 4000 psi. Therefore, it is concluded that the internal defects are structurally insignificant, and are only required to be fixed in the areas where concrete had been removed for the investigation.

- c) Debris was found on the exterior faces near the construction joint at EL 179.0. The debris did not extend to the interior of the joint and was traced from the outside. The condition was caused by the surface contour of the joint, which formed a pocket between the concrete and the form. Cores showed the interior of the joint to be roughened and well consolidated.

Repairs

After completion of the above investigations/evaluations the following corrective action repairs to concrete placement 521-1B were effected.

- 1) All surface defects were removed by chipping to sound concrete. The surface areas of the wall were then repaired using a shotcrete process in accordance with Fegles Procedure CP-303-11, "Concrete Repair by Shotcrete Process".
- 2) The regions of unconsolidated concrete found in the exploratory chippings were repaired with dry pack bonded with epoxy in accordance with Fegles Procedure CP-303-05, "Concrete Repair and Inspection".
- 3) As further outlined in Procedure CP-303-05, all debris as well as any improperly consolidated concrete was removed from the construction joint by chipping and repaired with dry pack grout secured with epoxy.
- 4) All core holes and exploratory windows have been repaired by coating the surfaces with epoxy and replacing the concrete in these areas.

Repair Verification

In accordance with Fegles shotcrete procedure, cores were taken of the shotcrete repair for insitu strength and bond verification.

The shotcrete exhibited good bond as evidenced by cracking through the aggregate at the joint in one core and a nearly invisible seam in the other. Also, in general, the shotcrete appeared sound with a uniform distribution of air and fine aggregate. The compressive strength test results indicate values well over the design requirement.

To develop a higher level of confidence in the bond or repair additional cores were taken in the shotcrete repaired area. The bonding exhibited in these cores was also found to be acceptable.