

SSER

Task: Allegation A-139

Reference No.: 4-84-A-06-34

Characterization: The concrete cracks identified in the summer of 1983 have been dispositioned as shrinkage cracks. This disposition is based on the assumption that the mat was placed in strict accordance with the specification and applicable American Concrete Institute (ACI) documents. However, the review of the records indicates that there were instances of poor concrete placement practices during the construction. The alleger is clarifying this allegation indicated he had no real concern about the integrity of the mat, but was concerned about whether all the records of deficiencies had been properly considered and all records had been reviewed.

Assessment of Allegation: The Nuclear Plant Island Structure (NPIS) housing all the seismic Category I structures is supported on a continuous reinforced concrete foundation mat 270 feet wide, 380 feet long and 12 feet thick. Section 3.8.3.2 of the Waterford Final Safety Analysis Report (FSAR) references ACI Standard 301, Specification for Structural Concrete for Buildings, with exceptions noted in Section 3.8.3.6. The project Specification No. LOU-1564-472, Concrete Masonry, embodies the project concrete construction procedures.

The concrete mat was constructed in 28 concrete placements. The review of some of the placement packages was conducted by the NRC staff to evaluate records. In addition, Stop Work Order (SWO) No. 1, Deficiency Reports (DRs), Deficiency Notices (DNs), Nonconformance Reports (NCRs), surveillance reports, project Specification No. LOU-1564-472, applicable J. A. Jones and EBASCO work procedures, construction photographs and drawings were reviewed. Several walkdowns were also conducted to observe the cracks.

The review of the placement packages indicated that the approximately 106 NCRs, 46 DNs and 42 DRs have been generated related to the base mat. The following items were found to be recurring problems:

- ° Excessive lift height
- ° Inadequate vibration
- ° Low air content
- ° Out-of-tolerance slump
- ° Inadequate curing logs.

Daily inspection records indicate that corrective actions were taken as soon as some of the above conditions were noted. Review of the NCRs generated to address the last three items indicate that the concrete batches not meeting the air content and slump requirements were rejected as soon as the test results were known. However, a few yards of concrete were placed prior to the discovery

of the test results. It is easily confirmed that these small quantities of concrete did not have any impact on the concrete strength by observing the fact that the average strength of all the concrete placements was about 5,300 psi, approximately 32 percent over the required design strength of 4,000 psi.

Curing deficiencies are, primarily, of record keeping nature. These deficiencies have been addressed by examining the weather data during the curing period and by the Windsor-probe tests for some placements to assure that the in-place strengths were not affected. From the review of these data, it is apparent that this record keeping problem has no impact on the structural integrity of the base mat.

Considering the technique of construction and the large volume of the concrete basically free of the reinforcement congestion, the instances of poor vibration and excessive lift heights are not considered to be circumstances which would produce inadequate consolidation or any voids of significance. Construction drawings and construction photos examined by the NRC staff indicate very clearly the lack of reinforcing congestion and the ease of accessibility for the placing crews and equipment. The lack of significant voids is also evident from the examination of the drilled cover from the placement 10B. The cores taken from the center portion of Block 10B do not indicate any voids as a result of inadequate consolidation (it should be noted that the average strength of the cores was 6,150 psi at 32 days). The poor consolidation has been found near water stops and the key-ways which are located next to the formed vertical faces of the blocks. The records for placements indicate that in the majority of the cases the voids were discovered and repaired right after the placement.

The review of SWO No. 1 (issued after the first three blocks were placed) and surveillance reports also indicate that the licensee made attempts to assure that deficiencies were corrected and concrete was placed in accordance with the licensee was reasonably successful in achieving a quality product in the basemat construction.

The NRC staff of the Allegation Task Force with technical support from an independent consultant believes the most likely cause of the initiation of cracking in the basemat to have been a result of tensile stresses induced by the restrained cooling of the concrete from the elevated temperatures generated by the cement's heat of hydration. While some cracks, they are more correctly termed thermal cracks. Shrinkage cracks are more appropriately characterized as surface cracks (perhaps as deep as 6" in thick sections) caused by loss of surface moisture.

The disposition of the NCR (NCR W3-6212) which addressed the cracks identified in the summer of 1983 did not characterize the cause of the cracking. The nature of the cracks was described as "widespread hairline cracking." The disposition included consideration of two issues: stability of the containment vessel and long-term corrosion, both of which were discussed in memoranda from 1977 when the first cracking was noted (NCR W3-535). Another EBASCO letter, dated July 27, 1977, which is not part of either NCR does address a

possible cause of cracking. That cause was stated to be "the results of the concave shape (high at the containment) which the mat has assumed due to differential settlement."

Based on the above review, the NRC staff concludes that the construction of the concrete basemat has met the intent of the project specifications and the FSAR criteria and that the observed cracks are not the result of observed and recorded deficiencies during the concrete placement operations.

The staff discussed the results of the documents review with the alleged in a meeting as stated earlier, the alleged primary concern was with the record keeping and not with the structural integrity aspects of the basemat.

Potential Violations: No violations were identified during the review which indicated safety concerns.

Actions Required: None.

References:

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12. EBASCO Dwgs. LOU-1564: G-499S01, G-499S02, G-499S03, G-500S01, and G-500S02.
13. Surveillance Reports.

Statement Prepared By:

N. C. Chokshi

Date

J. A. Devers

Date

R. E. Shewmaker

Date

Reviewed By:

Team Leader

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Site Team Leader(s)

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Actions Required: None.

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Actions Required: None.

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Team Leader

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Task Management

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Other
SSER

Shoulder Rev 3
7/26/84

DRAFT 2
07/19/84

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① Curing deficiencies are, primarily, of record keeping nature. ^{Curing} These deficiencies have been addressed by examining the weather data during the curing period and by the Windsor-probe tests for some placements to assure that the in-place strengths were not affected. From the review of these data, it is apparent that this record keeping problem has no impact on the structural integrity of the base mat.

and

Considering the technique of construction and the large volume of the concrete basically free of the reinforcement congestion, the instances of poor vibration and excessive lift heights are not considered to be circumstances which would produce inadequate consolidation or any voids of significance. Construction drawings and construction photos examined by the NRC staff indicate very clearly the lack of reinforcing congestion and the ease of accessibility for the placing crews and equipment. The lack of significant voids is also evident from the examination of the drilled cover from the placement 10B. The cores taken from the center portion of Block 10B do not indicate any voids as a result of inadequate consolidation (it should be noted that the average strength of the cores was 6,150 psi at 32 days). The poor consolidation has been found near water stops and the key-ways which are located next to the formed vertical faces of the blocks. The records for placements indicate that in the majority of the cases the voids were discovered and repaired right after the placement.

The review of SWO No. 1 (issued after the first three blocks were placed) and surveillance reports also indicate that the licensee made attempts to assure that deficiencies were corrected and concrete was placed in accordance with the licensee was reasonably successful in achieving a quality product in the basemat construction.

The NRC staff of the Allegation Task Force with technical support from an independent consultant believes the most likely cause of the initiation of cracking in the basemat to have been a result of tensile stresses induced by the restrained cooling of the concrete from the elevated temperatures generated by the cement's heat of hydration. While some cracks, they are more correctly termed thermal cracks. Shrinkage cracks are more appropriately characterized as surface cracks (perhaps as deep as 6" in thick sections) caused by loss of surface moisture.

The disposition of the NCR (NCR W3-6212) which addressed the cracks identified in the summer of 1983 did not characterize the cause of the cracking. The nature of the cracks was described as "widespread hairline cracking." The disposition included consideration of two issues: stability of the containment vessel and long-term corrosion, both of which were discussed in memoranda from 1977 when the first cracking was noted (NCR W3-535). Another EBASCO letter, dated July 27, 1977, which is not part of either NCR does address a

① What is the question?

possible cause of cracking. That cause was stated to be "the results of the concave shape (high at the containment) which the mat has assumed due to differential settlement."

Based on the above review, the NRC staff concludes that the construction of the concrete basemat has met the intent of the project specifications and the FSAR criteria and that the observed cracks are not the result of observed and recorded deficiencies during the concrete placement operations.

The staff discussed the results of the documents review with the alleged in a meeting as stated earlier, the alleged primary concern was with the record keeping and not with the structural integrity aspects of the basemat.

7. Potential Violations: ~~No violations were identified during the review which indicated safety concerns.~~ SEE SSERS

Actions Required: None.

References:

1. WSES FSAR Unit 3, Sections 3.8.3.2 and 3.8.3.6
2. Project Specification No. LOU-1564-472.
3. Stop Work Order No. 1, dated December 16, 1975.
4. DRs, DNs, and NCRs.

	NCRs		DNs		DRs
22	124	7151	C-7		56
52	174	7154	C-12		54
64	535	7353	C-13		13
78	6212	7481	C-27		14
93					
97	6245				
106	7149				
723	7150				

5. Placement Packages for blocks 11A, 15, 14A, 5A, 9A, 10A, 4.5B, 8B, 7B, 10B, 17, 16, 6, 2, 11B, and 9B.
6. SCD Report No. 1.
7. Mat 10B placement report, May 1976.
8. 'Evaluation of Concrete in the basemat Waterford Unit No. 3,' R. E. Philleo, May 1984.
9. EBASCO procedures QCIP6 and 7.
10. J. A. Jones Procedures W-WP-7, W-WP-8, and W-SITP-4.

11. Construction Photographs 468, 492, 502, 4513, 515, 518, 520, 554, 568, 575, 578, 607, 670, 692, P060035, P060036, P060012, and P060028.
12. EBASCO Dwg. LOU-1564: G-499S01, G-499S02, G-499S03, G-500S01, and G-500S02.
13. Surveillance Reports.

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