UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

Report No. 50-395/79-38

Licensee: South Carolina Electric and Gas Company
P. O. Box 764
Columbia, South Carolina 29218

Facility Name: Summer, Unit 1

Docket No. 50-395

License No. CPPR-94

Investigation at Summer Site near Columbia, South Carolina and Gilbert Associates, Inc. Offices, Green Hills, Pennsylvania

Inspectors: J. J. Lenahan — 2/7/80 Date Signed

R. Marsh, Regional Investigator, Office of the Director — 2/7/80 Date Signed

Approved by: for James P. O'Reilly, Director — 2/7/80 Date Signed

SUMMARY

Investigation on November 19-21, 1979, at Summer site; November 29, 1979, at Green Hills, Pennsylvania.

Areas Inspected

This investigation involved 18 inspector-hours onsite and 7 inspector-hours in the Gilbert Associates, Inc. offices in the areas of allegations concerning a cold joint in the reactor building ring girder, cracks in the service water tunnel, Cadwelding, increases in seismic activity since filling of the main reservoir, and waiving of cold weather concreting requirements.

Results

Two of the allegations (paragraphs 7.d and 7.e) were partially correct as stated; however, the licensee's QA program had detected the difficulties and adequate corrective action was taken. Therefore, there was no safety significance to the allegations. The other allegations were not substantiated. Of the areas inspected, no apparent items of noncompliance or deviations were identified.

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DETAILS

1. Persons Contacted

Licensee Employees

***D. A. Nauman, Group Manager, QA & Security
*A. A. Smith, Site QA Supervisor
***H. Radin, Senior Engineer
R. Lindler, Civil QC Supervisor
L. Hipp, Site Management Group (formerly Field Civil QC Supervisor)
E. Evans, QA Engineer
*R. B. Whorton, Resident Engineer, Civil
*O. S. Bradham, Operations Station Manager

Other Organizations

*W. L. West, Project Quality Manager, Daniel Construction
**G. T. Demoss, Structural Engineer (fromerly Structural Resident Engineer), Gilbert Associates
**E. Wielkopolski, Project Manager, Gilbert Associates
**R. M. Eshbach, Project Structural Engineer, Gilbert Associates
**K. E. Nodland, Structural Manager - Nuclear, Gilbert Associates
**R. N. Chokshi, Structural Engineer, Gilbert Associates
**J. F. Fulton, Structural Engineer, Gilbert Associates
**J. E. Lisney, Structural Engineer, Gilbert Associates
**F. L. Moreadith, Chief Structural Engineer, Gilbert Associates

NRC Resident Inspector

*J. Skolds

Other NRC Personnel

D. Anderson, I&E Region IV, Principal Inspector
P. Sobel, NRR, Geophysicist (telephone conversations)

*Attended exit interview November 21, 1979
**Attended exit interview November 29, 1979
***Attended exit interview November 21 and 29, 1979

2. Exit Interview

The investigation scope and findings were summarized on November 21 and 29, 1979 with those persons indicated in Paragraph 1 above.

3. Licensee Action on Previous Inspection Findings

Not Inspected.

4. Unresolved Items

Unresolved items were not identified during this investigation.

5. Independent Inspection Effort

There was no independent inspection effort conducted during this investigation.

6. Scope of Investigation

An individual contacted NRC Region II representatives and expressed concern with the design and construction at SCE&G's Virgil C. Summer Nuclear Plant. This individual also supplied the name of two other individuals who he felt may have additional concerns with the plant's design and construction. These two individuals were contacted prior to the investigation and interviewed by an NRC investigator to determine what their concerns were. This special investigation was conducted to followup on the concerns and allegations in the area of civil engineering which were expressed by these three individuals. The specific concerns and allegations addressed during this investigation were as follows:

a. The engineering evaluation of possible cold joints which occurred during placement of the fourth lift of the reactor building ring girder.

b. Inspection and evaluation of cracks in the service water intake tunnel after filling of the service water pond.

c. The change in seismic activity at the site following filling of Monticello Reservoir.

d. Relaxation of cold weather concrete requirements.

e. Cadwelding problems resulting from inadequate QC inspection.

7. Allegations or Concerns, Discussions, and Finding

a. Allegation

Problems were encountered in placement of the 4th lift of the reactor building ring girder which resulted in possible cold joints in some segments of the placement at elevation 574'9" and elevation 576'5". The alleger stated that a verbal stop work order issued by a SCE&G QC supervisor after the first cold joint had formed was refused by the contractor. In addition the alleger stated that the engineering evaluation of the "cold joint" considered only horizontal joint surfaces when in fact the cold joint had a sloping surface in some

areas. The alleger questioned whether or not the engineering evaluation of the cold joints was adequate and whether or not this item was reportable under NRC regulations.

Discussion

The inspector reviewed Nonconformance Notice (NCN) number 414C which was written to document and evaluate suspected cold joints in the fourth lift of the reactor building ring girder. The locations of the suspected cold joints were at elevation 574'-9", from azimuth 316° to 332° and from azimuth 0° to 31°, and at elevation 576'-5" in approximately one-third of the placement from azimuth 277° clockwise to azimuth 100°. The alleger verified that thes were the locations that he was concerned about. This NCN also dealt ch repair of honeycomb which occurred during the same placement in th bottom portion of a keyway for a non-structural parapet wall.

The inspector examined the following documents at Summer site which related to the concrete placement (pour number RBW 2524) and disposition of the NCN:

(1) Concrete pre-placement checklist (FQC Form 5.2.4-1)

(2) Concrete placement preparation checklist (FQC Form 5.2.4.3)

(3) Concrete placement checklist (FQC Form 5.2.5-1)

(4) Curing concrete and form removal checklist (FQC Forms 5.2.6-1 and 5.2.6.2)

(5) Defective area in concrete checklist (FQC Form 5.2.6-7)

(6) Gilbert Associates' (GAI) letter CGGS-15756, dated June 9, 1978, Subject: Reactor Building Ring Girder, Resolution to NCN-414C.

(7) GAI letter CGGS-15784, dated June 13, 1978, Subject: Reactor Building Ring Girder, Resolution to NCN-414C

(8) GAI letter CGGS-15769, dated June , 1978, Subject: Minute of Meeting. The meeting was held in GAI offices to discuss and finalize GAI engineering resolution of the suspected cold joints in placement number RBW-2524.

(9) SCE&G memo, letter number CGGS-1281-QC, dated March 22, 1978, Subject: Reactor Building Ring Girder Placement, RBW 2524. This memo was prepared by the civil discipline QC supervisor and describes the events which occurred during the concrete placement which led to suspected cold joints.

(10) SCE&G memo, letter number CGGS-1280-QC, dated March 21, 1978, Subject: RBW-2524. This memo was prepared by the concrete QC field coordinator and discusses the observations he made during placement number RBW-2524.

The inspector also examined the remains of 4 of 19 concrete cores which were drilled in the ring girder by the licensee to evaluate the suspected cold joint at elevation 576'-5". The inspector interviewed the civil discipline QC supervisor, the former concrete QC field coordinator and Gilbert Associates' (GAI) structural engineers who were involved in evaluation and disposition of NCN-414C.

Review of the above documents and discussions with the civil discipline QC supervisor, and the former concrete QC field coordinator indicated there was some confusion during the concrete placement, as to whether or not cold joints had actually formed at the areas in questions. The definition of a cold joint given in Section 5.2.4 of the Field Quality Control Manual states that a cold joint is any surface where intermingling of fresh and placed concrete is prevented by early setting of placed concrete or from a more practical viewpoint, placed concrete that a working vibrator cannot freely penetrate. Based on this definition, QC inspection personnel suspected that a cold joint may have formed at elevation 574'-9" from azimuth 316° to 332° when the concrete did not become readily plastic when it was vibrated and the observation that the vibrator could only penetrate 4 to 5 inches into the concrete surface. The civil discipline QC supervisor informed the contractor that he suspected that this was a cold joint condition and that the contractor could continue the placement as a nonconforming condition until the situation was clarified. Since it was somewhat unclear whether this was actually a cold joint, the GAI Structural Section Manager was contacted in order to clarify the definition of cold joint stated in the project specifications. (The specifications were written by GAI.)

Since vibrators were able to penetrate the concrete under their own weight from 4 to 5 inches, the GAI Structural Section Manager stated that this was not a cold joint and to continue the placement. When a suspected cold joint occurred at elevation 574'-9" from azimuth 0° to 31°, the GAI structural section manager was again consulted. Since the vibrators were able to penetrate the concrete in this area under their own weight for a depth of about two inches, the GAI representative again recommended that concrete placement continue. He further instructed the civil discipline supervisor that concrete placement should continue as long as vibrators can penetrate the inplace concrete under their own weight for a depth of at least one inch.

The civil discipline QC supervisor and the concrete QC field coordinator were questioned regarding the contractor's refusal to stop work on the pour. Both individuals stated that there was disagreement between the contractor's civil engineer and themselves as to whether or not the condition of the concrete at elevation 574'-9" from azimuth 316° to

332° was a cold joint. The concrete QC field coordinator stated that he instructed contractor personnel not to place concrete in the area of the suspected cold joint until the condition was clarified. The contractor complied with his instructions, and did not place concrete in this area until after he was instructed to do so by the concrete QC field coordinator. However, the contractor was permitted to proceed with placement of concrete in areas not affected by suspected cold joint formulation. Both the civil discipline QC supervisor and the concrete QC field coordinator stated that at no time during this placement did the contractor refuse a stop work order.

The civil discipline QC supervisor and the concrete QC field coordinator were questioned concerning the orientation of the surface of the suspected cold joints. Both agreed that the joints were not horizontal in all locations, and at times were sloping toward the liner plate.

The inspector examined the following at the GAI offices: Photos of concrete cores which had been drilled from suspected cold joint areas at elevation 576-5" in the ring girder, 6 of the concrete cores, GAI design calculations made to evaluate the suspected cold joints, and a report titled "Report of Concrete Evaluation for Gilbert-Commonwealth-Reactor Building-Fourth Lift Ring Girder", prepared by Construction Engineering Consultants, dated April 5, 1978.

After the pour had been completed and the NCN written, a GAI concrete specialist and a concrete engineer from Construction Engineering Consultants visited the site to investigate the suspected cold joints. Based on review of field reports, discussions with responsible engineers and QC personnel, and observations of the completed pour, they concluded that the suspected cold joints at elevation 574-9" were not cold joints. This conclusion was based primarily on the observation that the concrete in the suspected cold joint areas at this elevation could be penetrated by vibrators under their own weight for depths of 2 to 5 inches. However, based on descriptions of the areas of the suspected cold joints at elevation 576'-5" which could only be penetrated by vibrators to a depth of one to two inches, and the presence of honeycomb in the parapet wall keyway, they recommended that concrete cores be drilled through the suspected joint locations to further evaluate this area.

Due to the configuration of the forms, there was no concern over presence of unbonded concrete occurring in the suspect joint area toward the liner plate (inside of wall pour). For this reason the concrete cores were drilled from locations between the 1st and 2nd hoop bars, toward the ouside face of structure. When unbonded concrete was encountered at the suspected joint area in three cores, additional cores were drilled between the 2nd and 3rd hoop bars to delineate the joint area where unbonded concrete existed. All additional cores drilled between the 2nd and 3rd hoop bars showed sound concrete in the suspected joint area.

The inspector reviewed the design analysis performed by GAI to analyze the shear transfer capability of the joint. The assumptions made in the analysis was that the unbonded concrete encountered in three cores at the joint, even though it was confined to only three localized areas, was present for the outer one-third of the joint around the entire perimeter of the structure. The joint was then analyized using the shear-friction provisions of ACI 318-71, Building Code Requirements for Reinforced Concrete. Per the code requirements, the coefficient of friction factors used in the analysis were 1.4 for the monolithic concrete in the inner two-thirds of the joint and 0.7 for the unbonded concrete in the outer one-third of the joint. Review of the design calculations disclosed that the loading condition when the shear was the greatest in the suspected joint area occurred after stressing of the dome and vertical tendons and prior to stressing of the hoop tendons. For this loading condition, the allowable stresses per ACI-318 were 1.37 times greater than the actual stresses imposed by this loading condition. For normal operating and various accident conditions, the shear stresses acting on the joint are less than one-half of the ACI-318 allowable stresses. (Note: The allowable stresses given in ACI-318 are the maximum permissible stresses to be used in design of structures. These stress values are based on factors of safety against rupture or yielding of any type. In design of structures, the designer bases member sizes and selects required amount of reinforcing steel so the actual design stresses in each part of the structure are not greater than the ACI-318 allowable stresses. It is not necessary to include additional safety factors in the analysis since they have already been considered in setting the allowable stress values).

Not withstanding the conclusions of field reports which clearly indicated a cold joint did not occur at elevation 574-9", a design investigation was made to verify that even if a joint existed at this elevation, there would be shear transfer capability across the joint. In this design analysis, a coefficient of friction of 0.9 was used in the shear friction formula. This value is lower than the coefficient of friction value of 1.0 which is normally used in analysis of construction and cold joints by the shear friction method. Examination of these design calculation disclosed that the actual shear stresses imposed by various design loading conditions on the joint, if one had existed, would be well below the ACI-318 allowable values.

The inspector discussed the orientation of the suspected cold joints with the designers and what effect joint surfaces which sloped toward the liner would have on the analyses. These discussions disclosed that the assumption of horizontal joint surfaces resulted in the most conservative analysis. A sloping joint surface would have greater shear transfer capability since the area of reinforcing steel in the sloping joint plane to resist shear stresses would be slightly greater. Also the shear stresses acting on the sloping plane would be slightly reduced.

Findings

Following completion of the concrete placement in question, an NCN was written to document and evaluate the suspected cold joints. In order to disposition the NCN, several detailed engineering investigations were undertaken by the designer, GAI. The licensee reviewed in detail the disposition of the NCN, and in addition instituted several changes in concrete placement procedures to prevent recurrence of similiar problems on future concrete placements. The design analysis conducted to evaluate the suspected cold joints appears to be adequate and conservative. Consideration of sloping joint surfaces, had it been appropriate, in the analyses would have had no adverse affect on the conclusions reached in these analyses. This item was not reportable to NRC under 50.55(e). The allegation was not substantiated. No items of noncompliance or deviations were identified.

b. Concern

An individual expressed concern that movement (settling/lifting) of the service water intake pipe and pumphouse, which resulted from the filling of the service water intake pond and reservoir, may have further expanded cracks in the floor of the intake pipe. These floor cracks were identified in earlier licensee inspections as being less than .012 inches and therefore not pressure grouted. The alleger expressed concern over the adequacy of the licensee's investigation and corrective actions associated with these cracks.

Discussion

The service water intake structure had cracked during construction due to excessive differential settlements. The licensee reported this to Region II as required by 10 CFR 50.55(e). The cracks with widths greater than 0.012 inches were grouted in December 1977 and January 1978. The service water reservoir was filled in February-March 1978. During an inspection conducted on February 12-14, 1979, the inspector made a detailed review of documents concerning the grouting operation to repair the cracks in the service water intake structure. Documents examined during the February 12-14, 1979 inspection were as follows:

(1) Specification "Technical Requirements for Filling Cracks in Concrete With Epoxy Grout"

(2) Preliminary Test Program Checklist

(3) Receiving Inspection Checklists for Epoxy Grout

(4) SCE&G Compression Test Results Performed on Epoxy Grout Materials

(5) QC Records of Grouting Inspection

(6) Completion Report - Grouting Cracks in Walls and Roof of Service Water Intake Structure, dated January 21, 1978

(7) Service Water Intake Structure Settlement Effects and Related Work, Report Numbers 1 and 2.

In addition, the inspector examined 10 of the 15 core samples taken of the grouted cracks in the structure. Based on the examination of the above records and cores, the inspector concluded that the cracks in the tunnel had been satisfactorily repaired.

During this inspection (November 19-21, 1979), the inspector reviewed settlement survey data collected since filling of the reservoir and report "Final Report, Service Water Intake Structure, Settlement Effects and Related Work" dated October 1979. Review of the settlement data disclosed that the intake tunnel is rebounding slightly. However, the amount of differential movement measured at each data point is roughly proportional to the total differential settlement of that point which occurred during construction. That is, the movement of the tunnel which has occurred since filling of the pond is tending to decrease the net differential settlement of the structure. This means the size of the cracks in the floor of the tunnel have decreased, not increased, since filling of the service water pond. Included as Appendix A to the final report were results of a detailed underwater inspection of the tunnel conducted by divers from Salmons Dredging Corporation from June 7-13, 1979. The divers identified four hairline cracks in the walls of the tunnel. These cracks were all reported to be smaller than 0.014 inches and should have no effect on the structural integrity of the tunnel.

The licensee will continue to monitor the settlement (rebound) of the intake structure. This will be a technical specification requirement. If there are any significant changes in the movement of the structure, additional underwater inspections will be conducted.

Findings

The repairs to cracks in the water intake tunnel appear to have been satisfactory. No cracks have been found in the structure which will affect its integrity.

No items of noncompliance or deviations were identified.

c. Concern

An individual expressed concern over an apparent increase in seismic activity at the plant site since impoundment of water in the Monticello Reservoir.

Discussion

During hearings on the application to construct V. C. Summer plant, the licensee made a commitment to NRC to monitor changes in seismic activity due to the filling of Monticello Reservoir. In order to accomplish this, four seismograph stations were established in the vicinity of the reservoir and plant site. Monitoring of seismic activity was started on December 1, 1977, one day before impoundment of water in the Monticello Reservoir began. The reservoir reached maximum pool elevation on February 9, 1978. Data collected by the U. S. Geological Survey JSC Station, which is located approximately three miles from the plant site, was used to establish the pre-reservoir filling (or background) seismic activity in the plant area. The licensee has submitted monthly reports for the months of December 1977 through March 1978 to NRC containing the data collected from the seismographs. Since March 1978, quarterly reports have been prepared and submitted to NRC.

Data collected to date show an increase in microearthquake activity in the plant area since the reservoir was filled. NRC has retained the Los Alamos National Laboratory to evaluate the change in seismic activity and to determine what effect it will have on the safe operation of the plant. This determination will be made prior to issue of an operating license for the plant.

Findings

NRC is evaluating what effects changes in seismic activity at the plant site since filling of Monticello Reservoir will have on safe operation of the plant.

No items of noncompliance or deviations were identified.

d. Allegation

Cold weather concrete practices were relaxed in order to expedite construction.

Discussion

Through reference to ACI Standard 306, "Recommended Practice for Cold Weather Concreting", specification requirements were interpreted to require surfaces on which concrete was to be placed to be above a temperature of 32°F. When difficulty was encountered in raising the concrete and rebar temperature to above 32°F for the third placement of the reactor building ring girder (February 1978), the GAI Resident Engineer consulted the GAI concrete specialist to clarify ACI 306 requirements.

The inspector reviewed the following documents at the site which contained discussions concerning interpretation of ACI 306 requirements:

(1) GAI Resident Engineer Report for week ending February 3, 1978.

(2) GAI Resident Engineer Report for week ending March 3, 1978.

(3) Memorandum from GAI Resident Engineer to Civil QC Discipline Supervisior, dated August 28, 1978, subject, Concrete Placement Temperatures on Cold Surfaces.

The GAI concrete specialist concluded that ACI 306 banned placement of concrete on frozen surfaces, but not on cold surfaces. The GAI concrete specialist advised that the minimum surface temperature on which concrete was to be placed should be no lower than 25°F, and that concrete have a batching temperature of between 45°F and 50°F in order to keep the temperature difference between the concrete and surface "as close as practical" as stated in Section 3.1 of ACI-306. Based on these clarifications, QC released the concrete placement for the third lift of the reactor building ring girder. However, in order to prevent freezing of the new concrete, QC was instructed that the temperature of the surface on which concrete was to be placed should not be lower than 25°F.

Findings

The allegation was partially substantiated. It was verified that the specification requirements for cold weather concrete practices are relaxed. However, prior to relaxing the requirements, an engineering evaluation was performed. The evaluation was technically adequate. Relaxation of the cold weather concrete requirement had no effect on the integrity of the structure and no effect on safety. No items of noncompliance or deviations were identified.

e. Allegation

Inspection of Cadwelds was inadequate during construction.

Discussion

The licensee reported to Region II that problems were encountered with Cadwelds in the dome of the reactor containment building. This was reported as an item potentially reportable under the requirements of 10 CFR 50.55(e). The licensee performed a detailed investigation of these Cadwelds to address this item.

The inspector reviewed NCN 366C which was written to address and disposition the dome Cadwelds identified as rejectable by visual inspection. The Cadwelds were visually rejectable due to slag in the

tap hole or sleeve end, and in some cases, due to evidence of "blown" filler material. The investigation included performance of radiographs on visually rejectable Cadwelds, tensile testing, cross-sectioning for visual examinations, and cyclic load testing. All visually rejectable Cadwelds were removed from the structure and replaced with new Cadwelds. In addition, the manufacturer of the cadwelds (Erico) was consulted as to possible reasons for presence of slag in the Cadwelds and steps to be taken to correct the problem. Based on the discussions with Erico, changes were made to remove elements from the Cadwelding operation which may have contributed to the problem of slag in the Cadwelds.

Based on the results of tensile tests performed on the rejected Cadwelds, which all met the minimum specification requirements, the licensee concluded that the Cadwelds would have performed as required in the structure. Since these splices would not have constituted a significant deficiency in the structure had they gone undetected, this item was deemed not to be reportable under 10 CFR 50.55(e). However, steps were taken by the licensee, including increased QA/QC surveillance and recertification of Cadwelders, to correct Cadwelding problems.

The inspector discussed the Cadwelding problems which were identified in NCN 366C with the licensee QA staff. These discussions disclosed that an individual QC inspector may have been lax in performance of his inspection duties. The licensee furnished the inspector a copy of a proprietary report which contains an investigation of the individual's possibly inadequate inspection activities and a discussion whether or not they may have resulted in acceptance of inadequate Cadwelds in safety-related structures. The report concluded, based on the detailed testing and engineering evaluation performed to disposition NCN 366C, that the inadequate inspection activities performed by the individual would not have an adverse effect on the structural integrity of the structure. The individual resigned his position at the site after initiation of the investigation of his inspection activities by QA.

Findings

The Cadweld inspection activities conducted by the licensee appear to have been adequate. The allegation was not substantiated.

No items of noncompliance or deviations were identified.