U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Reports No. 50-454/84-30(DE); 50-455/84-23(DE)

Docket No. 50-454; 50-455 Licenses No. CPPR-130; CPPR-131

Licensee: Commonwealth Edison Company
Post Office Box 767
Chicago, IL 60690

Facility Name: Byron Station, Units 1 & 2

Inspection At: Byron Site, Byron, Illinois

Inspection Conducted: April 10-14; 23-27; May 16-18, 1984

Inspector: J. F. Norton 6/8/84
Date

Approved By: C. C. Williams, Chief 6/8/84
Plant Systems Section Date

Inspection Summary

Inspection on April 10-14; 23-27 and May 16-18, 1984 (Reports No. 50-454/84-30(DE); 50-455/84-23(DE))
Areas Inspected: Inspect concrete drilling and coring activities; structural integrity test; essential service water piping protection modifications; safety related manhole cover modifications; licensee action on Circular 81-08; structural modifications for river screen house; licensee action on Bulletin 79-02; and licensee action on concrete related violations No. 454/82-18-01; 455/82-13-01. This inspection involved a total of 80 onsite inspector-hours by one NRC inspector.
Results: No items of noncompliance were identified.

DETAILS

1. Persons Contacted

Commonwealth Edison Company (CECo)

*M. Lohmann, Assistant Construction Superintendent
*J. Woldridge, Quality Assurance Supervisor
*J. Mihovilovich, Lead Structural Engineer
R. Byers, Structural Engineer
D. Pyatt, General Engineer
R. Case, Structural Engineer

Blount Brothers Corporation (BBC)

R. Bay, QA/QC Manager
H. Williams, Project Manager

Roughneck Concrete Drilling and Sawing Company

F. Ramaghaour, Driller

U. S. Nuclear Regulatory Commission

*J. Hinds, Jr., Senior Resident Inspector
K. Connaughton, Resident Inspector
P. Prochman, Resident Inspector

*Denotes those who attended the exit meeting.

2. Licensee Action on Previous Inspection Findings

(Closed) Noncompliance (454/82-18-01; 455/82-13-01): The licensee failed to correctly translate certain concrete related regulatory requirements into the contract documents. In the corrective action taken, the licensee implemented appropriate changes in the FSAR, specifications and procedures to assure compliance with regulatory requirements. The changes were reviewed by the Region III inspector and found acceptable.

3. Functional or Program Areas Inspected

This inspection addressed concrete coring and drilling activities and quality records; the structural integrity test results for Unit 1; licensee action on Circular 81-08 addressing foundations and materials; licensee actions on Bulletin 79-02 addressing pipe support base plates; and licensee actions on commitments made in the SER including structural protection of essential service water piping, replacing certain manhole covers with extra-strength covers, and strengthening the structural qualities of the river screen house required because of re-evaluation of the structure's foundation.

4. Concrete Drilling and Coring

The adequacy of control over concrete drilling and coring activities was assessed, primarily to assure that pertinent information regarding damaged reinforcing steel is properly documented and dispositioned by the licensee and design engineers to ensure adequate structural integrity.

The scope of work for five site contractors was evaluated: Hatfield Electric Company, Hunter Corporation, Power-Azco-Pope, Johnson Controls Incorporated and Blount Brothers Corporation.

Typically, drilled holes are provided for the installation of concrete expansion anchors which range in size from ¼ inch to 1 inch in diameter, and have installation embedment depth of 5/8 inch to 8 inches respectively. Drilled holes partially penetrate the concrete section.

To facilitate evaluation of the drilling program, Sargent and Lundy (S&L) specification "Standard Specification for Concrete Expansion Anchor Work" and the work procedures of the five site contractors were reviewed. Additionally, Pittsburg Testing Laboratory procedure "Concrete Expansion Anchor Inspection" was reviewed. The specifications and all installation procedures contain adequate provisions to control drilling activities and identify and evaluate reinforcing steel which may have been damaged during work operations.

5. Cored Holes

Typically, cored holes range in size up to 12 inches in diameter, and completely penetrate the concrete section. Coring is accomplished in accordance with the following:

a. The contractor requesting core drilling submits a request with pertinent details to CECo engineering.

b. CECo engineering logs in the request, and convey the details to S&L Engineering.

c. A Field Change Request (FCR) is prepared by CECo, or an Engineering Change Notice (ECN) is prepared by S&L, as appropriate.

d. After the FCR or ECN is dispositioned, CECo engineering prepares a Core Hole Work Authorization and submits a purchase order with all pertinent details to Concrete Drilling and Sawing Company, the coring contractor.

e. The cognizant contractor QC personnel inspect the hole layout.

f. The coring contractor accomplishes the coring in accordance with the FCR or ECN provisions.

S&L logs all Core Drill Requests (CDRs) into their computer for tracking and record. All CDRs are reviewed for potential damage to structural integrity prior to authorization release. Relocation is sometimes

required. The core drilling contractor submits a Cut Rebar Report (CRR) at completion of drilling. A CRR is generated on every hole, even if reinforcing steel is not hit. One copy of the CRR is sent to S&L's Chicago office for review, and one copy is retained by CECO engineering.

A total of twelve core drill quality record packages were selected at random and reviewed. The sample included packages from each of the five contractors on site. Two of the record packages contained ECNs and the remaining were authorized on FCRs. All packages were complete with appropriate review signoffs, and were in good order.

Field observation of coring activities was accomplished on four corings: CDR No. 842 (2 inch diameter by 10 inch hole); CDR No. 799 (3 inch diameter by 42 inch); CDR No. 800 (3 inch diameter by 10 inch); and CDR No. 892 (5 inch diameter by 18 inch).

The coring program at Byron contains constraints which require appropriate review and authorization prior to drilling, and appropriate post-review and recording of rebar hits.

No items of noncompliance or deviations were identified.

6. Structural Integrity Test

Contractural Requirements

The structural integrity testing was performed on the Containment Structure, Unit No. 1. Wiss, Janney, Elstner Associates, Inc. (WJE) of Northbrook, Illinois was retained by Commonwealth Edison Company to install the prescribed instrumentation, monitor the response of the instruments, conduct crack surveys prior to and during structural integrity testing, and report on the results.

The location of test instrumentation was planned by Sargent & Lundy, Engineers, Chicago, Illinois. The work was conducted in accordance with Sargent & Lundy specification No. F/L-2922. All installations were performed or supervised by WJE personnel. That part of the work normal to their skills (routine installation of electrical lead wire, etc.,) was performed by tradesmen.

Ojective of Structural Testing

The instrumentation and subsequent structural integrity test was performed to accomplish the following:

a. Measure and record the structural response of the primary containment under design pressure loading of 50 psig.

b. Verify that the measured response is within the predicted design limitations and tolerances.

c. Demonstrate that the structural integrity of the primary containment structure is maintained under the 1.15 times design internal pressure load.

Pretest and Post-Test Examination

Prior to and after the structural integrity test, reasonably accessible portions of the exterior structure were surveyed for cracks. Accessible portions of the liner were surveyed to detect excessive deformation. Observations were made from all accessible walkways, floors, roofs and available scaffolding. In addition to the overall inspection, ten (10) areas were chosen for detailed crack mapping during the test. Each area measured 7 ft x 7 ft. Two of these areas also included the buttress face. Crack widths observed prior to, during and after the pressure test were measured using a 6X comparator. The crack width was recorded only if it exceeded 0.01 in.

Test Performance

The structural integrity test was conducted during the period from September 6 to 11, 1983. Gross deformation measurements were obtained at the following nominal levels: 0, 10, 20, 30, 40, 50, 57.5, 50, 40, 30, 20, 10 and 0 psig. Detailed crack inspections were made at 0, 10, 20, 30, 40, 50, 57.5 and 0 psig.

At each pressure level where structural data was required, pressurization was halted for one hour before data was obtained.

The data obtained at each pressure level were immediately reduced and printed out. The printout was reviewed by the Sargent & Lundy representative prior to starting to pressurize or depressurize to the next increment.

Displacements

At each specified pressure level a series of deflection measurements were made at selected locations as outlined below:

a. radial displacements of the cylinder on four azimuths at four elevations between the base slab and dome springline and at dome to cylinder transition;

b. radial displacements of the containment wall adjacent to the equipment hatch at 12 points, four equally spaced on each of three concentric circles, and the change in diameter of the hatch in the horizontal and vertical directions;

c. vertical displacement of the cylinder at the top relative to the base at four azimuths;

d. vertical deflections of the dome of the containment near the apex and two others approximately equally spaced between the apex and the springline on one azimuth.

The meters measuring change in radius between the inner face of the cylinder and interior reference structures indicated predicted values were exceeded by 14.3 percent and 11.7 percent, respectively. The meter

located on the liner just outside the equipment hatch barrel indicated 0.080 in. deflection at 57.5 psig. There may be some local effect of the thickened liner and barrel at this location which resulted in deflection measurements greater than expected. The 57.5 psig deflection at D31 was 0.134 in. which appears to be in line with measurements at D30 and D32. The measurements at D31 exceeded the predicted ones by 0.014 in.

After the structure was depressurized, deflection recovery was very good. Most instruments recovered more than 90 percent of their maximum deflection. In all cases the measured recovery within a 24 hour period after depressurizing was 80 percent or more.

Crack Inspection

Ten areas were selected for detailed crack inspection. The inspection areas had a one foot square reference grid marked on the surface.

The pretest crack inspection revealed only minor shrinkage cracks. All cracks observed were less than 0.01 in. in width. To facilitate inspection of the grid areas, observable cracks were mapped regardless of size. Crack widths were recorded only if they were greater than 0.01 in.

During the conduct of the test very few new cracks were observed. All old cracks remained essentially unchanged during the test. There was some extension of existing cracks. This extension would appear to be a continuation of an existing crack which was too small to be seen prior to the test. All cracks measured were between 0.002 and 0.006 in. in width. No crack exceeded 0.01 in. in width.

CONCLUSIONS

In most cases the measured deflections were less than predicted. At all locations the measured recovery was greater than 80 percent.

The majority of the measurements appear to have essentially a linear response and good recovery. This indicates that yielding of any of the materials in the containment structure did not develop. With the exception of two locations (D6 and D24), all displacements were less than predicted. Neither of these measurements exceeded the predicted values by more than 30 percent.

The pretest cracks observed in the designated areas were very small and probably the result of thermal and drying shrinkage. These are believed to be surface cracks. No appreciable change in crack widths were observed during the pressurization of 57.6 psig. There was no sign of any structural distress at any time during or after the test. No visible signs of permanent damage to either the concrete structure or the steel liner were detected.

The overall performance of the containment was such as to demonstrate that it is structurally capable of withstanding 1.15 times the internal design pressure.

No items of noncompliance or deviations were identified.

8. IE Bulletin 79-02

(Closed) Item No. 454/79-02-BB; 455/79-02-BB

Bulletin 79-02 addresses pipe support base plate design using concrete expansion anchors. The licensee responded to IE Bulletin 79-02 for the Byron plant on July 5, 1979 and January 4, 1980. The Office of Inspection and Enforcement requested the staff to review the licensee's response with respect to the pipe support baseplate flexibility and its effect on anchor bolt loads.

The staff performed an independent analytical verification of the techniques used to account for base plate flexibility and its effect on anchor bolt loads.

The independent analytical verification consisted of developing an elastic beam-based model of an anchored plate, subjected to static combined axial and moment loading. The concrete base is represented by elastic springs which are capable of sustaining compression only. The anchoring bolts are represented by springs which reproduce the non-linear behavior of the bolts during pull-out. The model also accounts for initial preload in the bolt-plate assembly. The solution to a given loading condition (i.e., bolt load vs. external load history) was obtained through an in-house developed computer program, which calculated the non-linear behavior in an incremental approach including equilibrium iteration.

Based on the review and independent verification, the staff concluded that the techniques submitted in response to IEB 79-02 correctly account for pipe support base plate flexibility and are therefore acceptable.

This review closes out the outstanding item "Baseplate flexibility and anchor bolt loading."

9. Licensee Action on SER Commitments

Structural Modifications to River Screen House

(Closed) Item No. 454/83-00-12; 455/83-00-12

In response to the staff's request, the applicant requalified the Byron River screenhouse structure using the enveloped spectra resulting from the elastic half-space and finite element methods. The requalification was limited to the SSE load combinations. The staff concluded that this limitation is acceptable inasmuch as the plant has been originally designed and analyzed for both OBE and SSE load combinations using the finite element method.

The analysis performed by the licensee indicated that in order to meet the requirements of the requalification of the river screenhouse at the Byron plant for the SSE load combinations some modifications to the superstructure was necessary, as follows:

a. Vertical bracing was required.

b. The connections for the vertically based column rows required additional reinforcing.

c. Cover plates were required on floor and roof beams.

The licensee informed the staff that these modifications would be accomplished prior to fuel loading. Based on the applicant's commitment, that these modifications would be accomplished, the staff considered this item to be resolved.

Conformance with Regulatory Guides 1.60 and 1.61 requirements provides reasonable ensurance that for an earthquake whose zero period accelerations are 0.09 for the OBE and 0.2 g for the SSE, the seismic inputs to Category I structures, systems and components are adequately defined to ensure a conservative basis for their design to withstand the consequent seismic loadings.

The licensee has met the relevant requirements of GDC 2 and Appendix A to 10 CFR 100 by appropriate consideration for the most severe earthquake recorded for the site with an appropriate margin and considerations for two levels of earthquakes (SSE and OBE).

The seismic design response spectra (OBE and SSE) applied in the design of seismic Category I structures, systems, and components comply with the recommendations of Regulatory Guide 1.60. The specific percentage of critical damping values used in the seismic analysis of Category I structures, systems, and components is in conformance with Regulatory Guide 1.61. The artificial synthetic time history used for the seismic design of Category I plant structures, systems, and components is adjusted in amplitude and frequency content to obtain response spectra that envelop the design response spectra specified for the site, which conforms to the recommendations of Regulatory Guides 1.60.

The Region III inspector reviewed the structural modifications achieved in the addition of vertical bracing and beams required to meet the revised seismic spectra for the River Screen House structure. The following drawings detail the modifications:

S-403BY Revision P
S-404BY Revision S
S-405BY Revision S
S-406BY Revision G
S-407BY Revision G
S-408BY Revision T
S-409BY Revision A
S-422BY Revision H
S-423BY Revision G
S-424BY Revision A

Drawings were issued on March 11, 1983.

Selected beams and bracing were inspected and verified to be in accordance with the drawings. The construction modifications were completed in late winter of 1984.

Essential Service Water Piping Protection

(Closed) Item No. 454/83-00-10; 455/83-00-10

The safety-related essential service water makeup pumps are located within the river screenhouse and thus are not protected from tornado-generated missiles. However, nonsafety-related onsite wells housed in missile-proof structures and capable of being powered from the diesel generator essential (Class 1E) power supplies provide a backup supply of makeup water to the essential service water cooling towers (the ultimate heat sink) if tornado-generated missiles, coupled with the loss of off-site power and a concurrent single failure, prevent operation of the essential service water makeup pumps. The staff concurred that the licensee's design for providing a tornado missile protected supply of essential service water makeup was acceptable.

Each unit has one essential service water cooling tower composed of four cells which serves as the ultimate heat sink. The towers are concrete structures designed to withstand tornado missile impact. However, exposed piping on the towers, and the cooling tower fans and fan motor drives located on top of the towers, were not protected from tornado generated missiles. The licensee committed (Tramm letter dated January 2, 1982) to provide protection for all piping external to the missile proof cooling tower walls.

Design/construciton modifications were made to encase exposed cooling tower return piping in concrete. The changes are detailed on the following drawings:

Drawings Revised

S-240BY Revision R
S-241BY Revision F
S-242BY Revision F
S-243BY Revision F
S-250BY Revision H
S-258BY Revision G

All listed drawings were issued May 26, 1982.

The Region III inspector verified the modifications to be in accordance with the design drawings. The work is completed.

10. Manhole Cover Replacement

(Closed) Item No. 454/83-00-21; 455/83-00-21

The licensee committed to replacing existing manhole covers for Category 1 manholes with ductile steel covers to provide necessary protection against tornado missiles. The following electrical drawings were revised

to detail the change: 6E-01096, Revision M; 6E-01097 Revision E; and 6E-01098 Revision F. All revised drawings were issued March 31, 1982. The manhole covers were verified by the Region III inspector to be changed as specified.

11. Circular 81-08 (Foundations and Materials)

The licensee has accomplished the "Recommended Action for Construction Permit Holders" at Byron as outlined in Circular 81-08. All seismic structures are placed on grouted bedrock except the River Screen House. Boring and grouting records are maintained in file QF 2862.24.

Settlement monitoring was initiated on April 11, 1977 for the main structures (Containments, Auxiliary building and Turbine building). Monitoring on the River Screen House began August 22, 1977. The surveyors notebooks for settlement readings are entered in the series 14 notebooks, "Miscellaneous Checks", filed under P.O. #176872. Calibration records for the instrument used are in notebook #5, same file. Settlement monitoring data was submitted to S&L for evaluation.

Section 2.5 of the FSAR was reviewed for the projected settlement figures for the Byron Site. Paragraph 2.5.4.10.2.3 for the Containments, Auxiliary, and Turbine building calculated a settlement of less than 1/2" on bedrock. For the radwaste and service building built on compacted crushed rock, settlement was estimated at 1/4 in. For the River Screen House built on compacted fill, Para. 2.5.4.10.3.3 estimated settlement at 1 in. The settlement monitoring data for the River Screen House indicates no significant settlement since early 1979. The data indicates maximum total settlements are less than 1/2 inch.

The Region III inspector reviewed the above referenced data and verified that actual structural settlement is within design predictions. Therefore, no further action on Circular 81-08 is required.

12. Exit Interview

The inspector met with licensee representatives and others (denoted under Persons Contacted) on May 18, 1984 at the conclusion of the inspection. The inspector summarized the findings, as reported herein, which were acknowledged by the licensee.