U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-440/84-20(DRS; 50-441/84-18(DRS)

Docket No. 50-440; 50-441 License No. CPPR-148; CPPR-149

Licensee: Cleveland Electric Illuminating Company
Post Office box 5000
Cleveland, Ohio 44101

Facility Name: Perry Nuclear Power Plants, Units 1 and 2

Inspection At: Perry Site, Perry, Ohio

C C Williams for

Inspector: J. F. Norton 9/13/84
Date

C C Williams

Approved By: C. C. Williams, Chief
Plant Systems Section 9/13/84
Date

Inspection Summary

Inspection on August 20-24, 1984 (Report No. 440/84-20(DRS); 441/84-18(DRS))
Areas Inspected: Licensee program on concrete drilling and coring; licensee action on IE Bulletin 79-02 "Pipe Support Baseplate Design Using Concrete Expansion Anchor Bolts" (Open Items 440/79-02-BB-1B-2B-3B; 441/79-02-BB-1B-2B-3B); and licensee action on Circular 81-08 "Foundation Materials" (Open Item 440/81-08-cc; 441/81-08-cc). This inspection involved a total of 42 onsite inspector hours by one NRC inspector.
Results: No items of noncompliance with NRC requirements were identified.

DETAILS

1. Persons Contacted

*C. Shuster, Manager, Quality Assurance
*K. Kaplan, Senior Engineering Technician, Procurement Administration Quality Section
*M. Plica, Civil Structural Supervisor, Nuclear Construction Engineering Section
*B. Thompson, Lead Civil Quality Engineer
*M. Kritzer, Supervisor, Civil/Structural Unit
*E. Riley, General Supervisor, Construction Quality Section
*P. Arny, Lead Inspector, Construction Quality Section
G. Daderlso, Construction Quality Engineer - Civil
J. Hagen, Resident Geotechnical Engineer
K. White, Civil Engineer
C. Angstead, Lead Design Engineer

*Denotes those present at the exit interview on August 24, 1984.

2. Functional or Program Areas Inspected

The inspection addressed licensee action relative to IE Bulletin 79-02 titled "Pipe Support Baseplate Designs Using Concrete Expansion Anchor Bolts"; Circular 81-08 titled "Foundation Materials"; and the concrete drilling and coring program.

a. Concrete Drilling and Coring

(1) The adequacy of control over concrete drilling and coring activities was assessed by the NRC inspector 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.

(2) The NRC inspector evaluated the scope of work for the two site contractors involved in concrete drilling and coring: Dick Corporation (Civil); and L. K. Comstock & Company Incorporated (Electrical).

(3) Typically, drilled holes are provided for the installation of concrete expansion anchors which range in size from 5/16 inch to 1 1/4 inch in diameter. Drilled holes partially penetrate the concrete section.

(4) Four types of anchors are used as follows: "Hilti Kwik Bolts" (1/4 to 1 1/4 inch diameter); "Drillco Maxi-Bolts" (1/4 to 1 1/4 inch diameter); "Williams Thrust Ring Headed Anchors" (5/16 to 1 1/4 inch diameter); and mild steel anchors which are A-307 bolts. The mild steel anchors are permitted in the vertical downward position only. The last two mentioned are used for drilled and grouted installations.

(5) In the process of evaluating the concrete drilling and coring program, the following documents were reviewed; Gilbert Associates Incorporated (GAI) specification (SP) 208 (Hilti Kwik Bolts); GAI SP-210 (Drilled and Grouted Anchors); GAI SP-212 (Drillco Maxi Bolts); CEI SP-33-4549 (Requirements for Field Drilling of Penetrations); Dick Corporation work procedure FQC-9.5, Revision 2 (Drilled and Grouted Anchors and Core drilling); L. K. Comstock work procedure 4.3.22 (Core Drilling Procedure); and quality records comprised of several Engineering Change Notices (ECNs) and Nonconformance Reports (NCRs) relative to drilling/coring from both site contractors. The ECNs and NCRs all reflected appropriate documentation, dispositioning and signoffs by qualified personnel.

(6) No on-going concrete drilling/coring was in progress during this inspection. The specifications, pertinent drawings, and installation procedures, collectively contain adequate provisions to control drilling activities and identify and evaluate potentially damaged reinforcing steel in the construction process.

No items of noncompliance or deviations were identified.

b. Cored Holes

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

(1) The location of reinforcing steel is determined by using a rebar locator, or by drilling small diameter exploratory test holes to verify that the penetration can be installed without excessive rebar interference.

(2) If the mapping of concrete with the rebar locator presents consistent and clear rebar patterns, a diamond tipped core drill is permitted, with the stipulation that no rebar can be cut or damaged. If the test hole option is selected to determine bar locations, or if the bar locator presents irregular or unclear patterns, small diameter exploratory test holes are required to determine a suitable location for the penetrations. The test holes are drilled with carbide tipped masonry bits.

(3) If rebar is damaged during the coring, the damage is documented on an NCR. Prior to dispositioning the subject NCR, no other core holes in that particular concrete area and/or member is permitted, unless specific direction to continue drilling is provided by the Engineer's on-site structural representative.

(4) No reinforcing bars are permitted to be intentionally cut without the written approval of the engineer.

(5) Any exploratory small diameter test holes which are abandoned are patched with Masterflow 713 grout or by dry packing in accordance with ACI-301 criteria.

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

No items of noncompliance or deviations were identified.

c. Circular 81-08

(Closed) Item No. 440/81-08-cc;441/81-08-cc

1. Circular 81-08, issued May 29, 1981, addresses foundation materials and embraces the geotechnical aspects of plant sites as they affect structural foundations and stability. For construction sites such as Perry 1 and 2 that have substantially completed geotechnical construction and have an ongoing settlement monitoring program, the intent of Circular 81-08 is satisfied by accomplishing the following:

   (a) Verifying that the settlement monitoring program is being implemented at the prescribed frequency and results are being evaluated by appropriate personnel.

   (b) Verifying that reference monuments are installed as specified, are adequate for intended use, and that data recorded is sufficiently accurate to provide good information.

   (c) Verifying that measured values, to date, fall within the projected values as indicated in the Safety Analysis Report. If recorded values exceed design values, verifying that the licensee has determined the cause and considered the reportability of the finding is necessary.

(2) The licensee has retained Garrett and Associates, Registered Engineers and Surveyors, to survey established points to monitor foundation movement of safety related structures on a monthly basis. These readings are reviewed by the licensee's Resident Geotechnical Engineers and Lead Civil Engineers, then submitted to Woodward-Clyde Consultants, Plymouth Meeting, Pennsylvania, for evaluation. Woodward-Clyde's last report was issued March 1, 1983. The Region III inspector reviewed the report in conjunction with all survey data to date.

(3) In comparing actual and predicted deformations, it should be noted that the deformations consists of three phases: heave of the shale bearing surface following excavation, rapid compression during construction and backfill of the structures and, finally, long-term post-construction consolidation at a very slow rate. The calculated deformation behavior for the reactor building is typical of all of the structures on the site.

(4) The computed heave of the shale within the main plant excavation ranged from about 1/2 to 3/4 inch. The actual heave was about 1/4 to 1/2 inch, except within the area of a bedrock deformation zone which was subsequently excavated.

(5) The computed immediate settlement for the auxiliary buildings, radwaste building and control complex was about 1/2 inch in the interior and about 1/4 inch along the edges of the buildings adjacent to the toe of the plant excavation. The analysis method, however, did not account for structural ridgidity of the foundation mats which would tend to decrease the interior settlement and increase the edge settlement. The actual immediate settlement of these structures, as measured at settlement points SP-1, SP-4, and SP-6, plus the disk in the control complex, has been about 1/4 to 3/4 inch, averaging about 1/2 inch. Long-term settlement after completion of construction is expected to be on the order of 1/10 inch.

(6) The calculated immediate settlement of the reactor buildings was about 3/4 inch in the interior and 1/3 to 1/2 inch along the edges. Again, the structural rigidity of the mat would tend to increase the settlement of the edges. The actual settlement, as measured at the 16 interior points on the reactor mat, as well as settlement points SP-2 and SP-3, has been about 1/2 to 1 inch. Long-term settlement, after completion of construction, is expected to be on the order of an additional 1/10 inch.

(7) It is concluded that foundation movement of the Seismic Category I structures is very slight and within the magnitude anticipated. Post-construction movement (non-seismic) is expected to be negligible.

(8) The licensee has a comprehensive monitoring program. Survey of points is accomplished monthly by Registered Surveyors. Reduced survey data is analyzed by knowledgeable on-site engineers, then evaluated by a reputable Geotechnical Consultant firm. No significant safety related foundation problems are apparent. The requirements of Circular 81-08 have been and are being appropriately addressed by the licensee.

d. Bulletin 79-02

(Closed) Item No. 440/79-02-BB-1B-2B-3B; 441/79-02-BB-1B-2B-3B

Background

(1) Bulletin 79-02 issued March 8, 1979, PIPE SUPPORT BASE PLATE DESIGN USING CONCRETE EXPANSION ANCHORS. The Bulletin and revisions require licensees to address eight facets as discussed in the following paragraphs.

(a) "Verify that pipe support base plate flexibility was accounted for in the calculations of anchor bolt loads." Safety factors (SF) of 4.0 for wedge and sleeve type anchor bolts and 5.0 for shell type are specified.

Wedge type expansion anchors were used exclusively in safety related areas of Perry Units 1 and 2. Base plates were considered rigid in the original design. For re-examination of the base plates considering plate flexibility, procedures were developed for the analysis of the plates and anchorages for moment and axial load applied to plate surfaces. Based on plate and anchor response to appropriately chosen design assumptions and paramaters, procedures were develcped to determine tensile forces in the anchors. Shear and tension effects were combined to evaluate the factor of safety of the anchors, with the shear force distributed equally to all anchors in the connections.

(b) "Verify that expansion anchors have a minimum SF of 4.0 for wedge type anchors."

The licensee developed a shear-tension interaction equation which conservatively determined the SF against failure. Applying the equation to the installed anchors, one anchor (1/2 inch diameter), failed the test with a SF of 3.5. This installation was changed to assure a SF > 4.0.

(c) "Describe the design requirements, if applicable, for anchor bolt to withstand high cycle operating loads and seismic loads."

Pipe support reactions are generated as an output of a dynamic analysis and are utilized for the design of the individual pipe supports. Therefore, a dynamic amplification factor was not theoretically required. However, to provide for the effect of hardware and erection tolerances, the operating basis earthquake (OBE) seismic part of the reaction was multiplied by a factor of 2 to produce a design load. This factor provided additional design margin on the dynamic part of the loads.

The governing load combination including the 2.0 factor is:

Deadweight +	Thermal +	(2.0) OBE Seismic +	Occasional Mechanical Loads <	Allowable Anchor Bolt Load

In order to ensure cyclic load carrying capability, wedge type anchors were installed by applying a torque of sufficient magnitude to set the wedges at a bolt preload equal to or greater than the maximum allowable working load.

(d) "Verifying from existing QC documentation that design requirements have been met for each anchor bolt in the following areas:

- Cyclic loads have been considered (e.g. anchor bolt preload is equal to or greater than bolt design load). In the case of the shell type, assure that it is not in contact with the back of the support plate prior to preload testing.

- Specified design size and type is correctly installed (e.g. proper embedment depth)."

When Bulletin 79-02 was issued, the status of the installation of safety-related pipe support base plate anchor bolts was that only twelve had been installed and none had received final torque. The twelve installed bolts were visually inspected to verify that they had been correctly installed and were the specified design size and type.

Subsequent to Bulletin 79-02 issue, the Perry Nuclear Power Plant QC program required 100% first line inspection of all safety-related pipe support base plate anchor bolts. The program verified that:

- The bolt preload was equal to or greater than the bolt design load (note: shell type bolts were not used).

- The bolts had been installed correctly and were of the specified design size and type.

(e) "Determine the extent expansion anchor bolts were installed in masonry walls to attach piping supports in seismic Category 1 systems."

No seismic category 1 supports utilize expansion anchors attached to concrete blocks at Perry.

(f) "Determine the extent that pipe supports with expansion anchor bolts used structural steel shapes instead of base plates." The following requirements are also set forth in IEB 79-02 item f:

1 Provide pertinent details of the systems involved.

2 Provide a detailed evaluation of the adequacy of the anchor bolt design and installation (where structural steel shapes are used instead of base plates).

3 Describe future plans and schedules for further actions necessary to assure affected systems meet Technical Specifications operability requirements in the event of an SSE.

Structural steel shapes, when used as base plate supports, were included in the analysis described under item 1 above.

(g) Item 7 of bulletin 79-02 applies only to operating plants, and is therefore not applicable to Perry.

(h) "Maintain documentation of any sampling inspection of anchor bolts required by Item (d)."

Summary and Conclusions

(1) The licensee performed a detailed review in accordance with the subject criteria of Bulletin 79-02. The review was performed on a representative sample of safety-related (Seismic Category 1) supports, and analyzed the possible effects of base plate flexibility on base plate anchors.

(2) Most plates were determined to be flexible as defined by Bulletin 79-02 criteria. Therefore, plates were reanalyzed using a method in which the effects of plate flexibility, anchor preload and shear-tension interaction were considered. The results of the reanalysis generally confirmed the adequacy of the original design.

(3) A representative sample consisting of 10 Perry designs and 96 similar designs were investigated. The Perry specific and similar design considered were anchored with Hilti "Kwik-Bolts". The analytical investigations indicated that approximately 5% of the Perry designs may have had a factor of safety less than 4.0 when plate flexibility was considered.

(4) The licensee committed to performing analytical work and appropriate redesign to ensure that all pipe support base plates conform to the requirements of Bulletin 79-02 and the ASME Boiler and Pressure Vessel Code, Section III. This was included in the design verification efforts for Seismic Category 1 supports.

(5) All Seismic Category 1 supports are potentially subject to a relatively low number of seismic loading cycles which can be accommodated by the design. Operational loads which could, during the lifetime of the plant, undergo a large number of load cycles are to be identified during startup testing, and modifications to the pipe support system are to be made as required to assure that such loads are accounted for.

(6) The results of the investigation for the effects of plate flexibility on pipe support base plate anchors indicate that, for most plates anchored to concrete surfaces with Hilti "Kwik Bolts", prying forces did not exist. Prying forces were found to be present in approximately 5% of the cases. In those cases the prying was responsible for an average increase in the bolt tension of less than 30%.

(7) All base plates for large bore (2 1/2" and larger) Safety Category 1 pipes have been or are being reanalyzed. There are approximately 500 base plates in the two units which fit this category. Small bore (2" and smaller diameter) pipe was designed using a seismic support spacing criteria. The criteria was developed based on a consevative pipe stress and a multi-span model for each pipe size and schedule. The model analysis provides pipe spans and support loads. This approach has been verified by sample computer analyses to be conservative relative to applicable code requirements.

A series of typical support designs were generated and load rated by analytical techniques. The supports were analyzed for structural adequacy for all members, welds, and expansion anchor bolts. In generating the load rating, the most conservative geometrical combination of the maximum distance from the pipe to the structure was used in conjunction with the smallest allowed spacing between expansion anchor bolts. This resulted in the worst load case. The results of this conservative approach indicate that about 15% of the supports on any of the small bore piping runs could fail and the piping stresses would remain within code allowables. Therefore, detailed analyses and inspection of these expansion anchor bolts were considered unnecessary.

(8) The licensee has appropriately addressed the elements of Bulletin 79-02 in accordance with the requirements.

3. Exit Meeting

The inspector met with licensee representatives (denoted under Persons Contacted) and conducted an exit meeting at the conclusion of the inspection on August 24, 1984. The licensee acknowledged the findings reported herein.