U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-341/84-30(DRS)

Docket No. 50-341 License No. CPPR-87

Licensee: Detroit Edison Company
2000 Second Avenue
Detroit, MI 48224

Facility Name: Enrico Fermi Nuclear Power Plant, Unit 2

Inspection At: Enrico Fermi 2 Site, Monroe, MI

Inspection Conducted: June 27-29 and July 10-12, 1984

Inspector: J. Norton 8-3-84
Date

Approved By: C. C. Williams, Chief
Plant Systems Section Date 8-3-84

Inspection Summary

Inspection on June 27-29 and July 10-12, 1984 (Report No. 50-341/84-30(DRS))
Areas Inspected: Special announced inspection to review concrete drilling and coring; licensee action on shore barrier structure (open item 341/81-10-01); and licensee action on Bulletin 79-02 (Pipe Support Baseplates). The inspection involved a total of 64 inspector-hours by one NRC inspector.
Results: In one of the areas inspected one item of noncompliance with NRC requirements was identified (Paragraph 3.J. failure to take appropriate corrective action - Criterion XVI).

## DETAILS

1. Persons Contacted

*G. Trahey, Director, Project Quality Assurance
*W. Holland, Vice President
*S. Noetzel, Assistant Project Manager
*W. Street, Supervising Engineer-Civil
*L. Bregni, Nuclear Operations Licensing Engineer
R. Bryer, Principal Engineer, Generation Engineering Department

Other Personnel

*P. Byron, Senior Resident Inspector, NRC
P. Gwynn, Resident Inspector, NRC
*J. Wells, Construction Assessment Team Leader, Duke Power
R. Noble, Consulting Engineer
D. Pederson, Training Coordinator, Bechtel
*P. Hutchison, Field Engineer, Sargent and Lundy
C. Arnold, Civil Concrete Inspector, Duke Power CAT Team

*Denotes those who attended the exit meeting.

2. Functional or Program Areas Inspected

This inspection addressed licensee action on the shore barrier structure; licensee action on Bulletin 79-02 addressing pipe support baseplates; and the concrete drilling and coring program.

3. Licensee Action on Shore Barrier Structure (Open Item 341/81-10-01)

a. The Shore Barrier Structure function is to provide wave impingement protection for safety related structures during the probable maximum surge. During the probable maximum surge, the Shore Barrier Structure will be submerged by up to 3.9 feet of water (maximum stillwater elevation is 586.9 feet). Waves that would impinge on safety-related structures are limited by this maximum depth of water, and the maximum breaking wave that can be supported in this depth of water is approximately 3 feet. Waves that are transmitted over the breakwater will approach the service building and radwaste building which are nearest to the lake. These buildings are not seismic Category I structures, but do afford some protection for seismic Category I structures from direct wave attack. Waves travelling around the ends of the breakwater, however, can reach and runup on seismic Category I structures, and the licensee has considered the resulting wave forces in the design of the structures. Seismic Category I structures considered in these analyses were the reactor building, the auxiliary building, and the residual heat removal building. In addition to considering the wave forces for the above postulated conditions, the licensee also provided airlocked and water proofed doors which are normally closed for all openings in the seismic Category I structures that are below the level of the maximum wave runup.

b. The structure borders the shoreline for 1050 feet. The armor layer of stone was designed to be 7.5 feet thick using 3.3 to 5.0 ton stone. Underlayers were specified as follows: The secondary layer to be 3.5 feet thick with 600 to 1000 pound stone; the filter layer to be 1.5 feet thick with 30 to 50 pound stone. Design crest elevation is 583.0 feet, toe elevation is 573.0 with a front (lakeward) slope of 1 on 1. The transverse dimension of the structure section is 80.0 feet. It has sheet pile cutoff bottoming at elevation 550.0 along the entire longitudinal distance of the lakeward toe. The piling cut off is also wrapped around each terminal end.

c. The licensee is committed to performing a survey (SER, pg 2-12) to assure construction conformance with the design, prior to the issuance of an operating license. During an inspection conducted in August of 1983, (Report 83-19), this inspector reviewed licensee action on the shore barrier structure (open item 341/81-10-01). An on-site inspection of the structure revealed several areas to be below designed crest elevation tolerances. The item remains open, pending the acquisition of survey data to properly assess the apparent deficiencies.

d. On August 18, 1983, DDR No. C-12154 was documented by the licensee to address the discrepancies in the shore barrier. The NRC inspector reviewed and discussed the licensee's action on the subject DDR. The following data is excerpted from the DDR documentation:

(1) DEVIATION There are several locations on the shore barrier structure where the cap stone deviates from the required design elevation by more than the tolerance of ±6 inches as specified in 3071-176 Revision B, Paragraph 3.4.5.1.

(2) FIELD PROPOSED DISPOSITION Use as is. Due to the size of the interlocking system of the cap stone, other stones could not be added or taken out without being out of tolerance in the opposite direction in the areas as stated in the survey.

(3) DETERMINATION OF CAUSE AND CORRECTIVE ACTION TO PREVENT RECURRENCE
Cause - N/A
Corrective Action - Contractor no longer on site - N/A

e. In the final disposition, the DECo Supervising Civil Engineer concurred with the field proposed disposition of DDR No. C-12154 citing certain survey cross section data (accumulated during construction) and a letter/report written by the design engineer.This letter/report addresses an inspection of the structure performed by the Design Engineer on March 10, 1981 when construction was in the final stages. The survey data and letter/report were attached to the DDR.

f. On June 27, 1984 (the first day of this inspection) the DDR data was reviewed by the Region III inspector in conjunction with a visual examination of the structure. Certain structural deviations, which were apparent during the field observations, were not accurately and comprehensively recorded in the DDR documentation. The site survey crew

was brought in to take cross sections at selected locations chosen by the NRC inspector, to verify and check the magnitude of deviations between existing structure configuration and that documented on the DDR supporting data. The sections taken by the survey crew showed crest elevations (at the top of designed slope) to be as low as 2.7 feet below the specified elevation. The design called for a 30 foot level crest section. The below grade deficiencies did not exist at the landward edge of the structural section, and the structural configuration is above design grade at the lakeward slope toe by up to about 4 feet in certain areas. The original survey data and the letter attached to the subject DDR were reviewed in the light of the data accumulated by the NRC inspector. This survey data documented eleven cross sections taken at 100 foot stations. The worst variations noted by the NRC Inspector were not evident in the original data because the sections were not taken where the most pronounced deficiencies existed. The data did record below-grade deficiencies ranging from 0.3 to 1.9 feet. The summary analysis of the survey data was misleading in that it represented an average of the elevation deviations. The average variation is minus 0.75 feet for all stations. In addition to this, the following statement was documented in the data analysis "These variations do not adversely affect the shore barrier performance."

g The Design Engineer conducted an inspection of the shore barrier on March 10, 1981. Certain items he discussed with the on-site Construction Superintendent were documented in a letter dated March 12, 1981. However, the section configuration variations were not addressed.

h. The following points were discussed with the licensee by the NRC Inspector. Design/construction variations of the above described magnitude appear to be significant. Either the structure must be constructed in accordance with design tolerances or it must be re-designed or evaluated to determine if the as-built structure, will perform as intended. It was also pointed out that if the designer re-evaluates the design and determines that the structure will perform satisfactorily as-is, these determinations must be reviewed by NRR since this represents an apparently significant deviation from the original design parameters documented in the SER.

i. The following deficiencies and omissions were noted by the NRC inspector in the dispositioning of DDR C-12154.

(1) The recommended action of the FIELD PROPOSED DISPOSITION was "use-as-is", even though survey information clearly indicated that construction tolerances were significantly exceeded.

(2) The available data (survey and designer's field trip letter) was misleading and contained errors of omission. This could have been readily determined by visual inspection.

(3) The analysis of the FIELD PROPOSED DISPOSITION is not acceptable. It indicates that correcting the structure to design configuration is impossible and apparently considers the contractors departure from the site as being relevant to taking appropriate corrective action.

(4) The licensee did not discern appropriate corrective action indicated by the magnitude of the structural deficiencies.

(5) The dispositioning was based on data which is erroneous and misleading, and was evidently not thoroughly analysed.

As is documented in the foregoing, the licensee's disposition of Deviation Disposition Request No. C-12154 regarding the shore barrier structure constitutes a violation of 10 CFR Part 50, Appendix B, Criterion XVI (50-341/84-30-01).

4. Bulletin 79-02

Background

a. Bulletin 79-02 addresses pipe support base plate design using concrete expansion anchors. Teledyne Engineering Services (TES) was authorized by fourteen utilities (including Detroit Edison) to provide engineering services which would assist the utilities in responding, in part, to USNRC I&E Bulletin 79-02, dated March 8, 1979. Bulletin 79-02 required response to a number of items associated with base plate flexibility and its concomitant effect on concrete expansion anchor bolts. It was determined by the Utility/TES group that a number of items in the bulletin were generic in nature and could be addressed more substantially by combining resources and technology.

The specific bulletin items addressed by the Utility/TES group were:

(1) The experimental development of shear-tension interaction curves to properly apply the bulletin safety factors for combined loading.

(2) Experimental determination of the adequacy of concrete anchor bolts that are not preloaded to withstsand cyclic loading.

(3) An analytical technique for determining the effect of base plate flexibility on concrete anchor bolt loading.

b. The Owner's Group was responsible for directing the efforts of TES and reviewing the specific tasks as they were performed and completed. On April 26, 1979, the Utility/TES group met with the NRC in Bethesda, Maryland to discuss this generic program and its applicability to Bulletin 79-02. Representatives from I&E and NRR were in attendance and their general conclusion was that "the proposed program would address the concerns for the base plate/anchor bolt installation in a fashion that is acceptable to NRC." The owner's group formalized the scope of work to be pursued by TES on April 12, 1979 at a utility/TES meeting.

c. TES submitted Technical Report TR-3501-1, Revision 1, dated August 30, 1979. The report presented the results of a generic program that responded, in part, to the Bulletin. Both experimental and analytical work was performed in this generic program. Shear-tension interaction tests and cyclic test of concrete expansion anchors were performed

and a pre and post processor to an existing finite element program was developed to facilitate base plate analysis. The important general findings of this program are:

(1) Concrete expansion anchor bolts which are preloaded do not deteriorate when subjected to cyclic loading.

(2) A linear assumption for shear-tension interaction loading on concrete expansion anchors is highly conservative.

(3) Base plate flexibility should be considered in determining the load on concrete expansion anchors.

(4) Testing performed under the program does not indicate a reason for applying different safety factors to different types of expansion anchors.

d. Subsequently, the NRC 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 was represented by elastic springs which were capable of sustaining compression only. The anchoring bolts were represented by springs which reproduced the non-linear behavior of the bolts during pull-out. The model also accounted 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 iteraction.

e. Based on the review and independent verification, the staff concluded that the techniques applied by TES correctly accounted for pipe support base plate flexibility and was therefore acceptable.

f. Licensee Action

When Bulletin 79-02 was issued on March 8, 1979, DECo had installed a total of 629 shell type concrete expansion anchors in 191 baseplates supporting piping. A test program was implemented, as documented in a letter (R. Tietz, Piping/Mechancial Manager to W. Everett, Edison Site Superintendent) dated February 17, 1981. The philosophy of the testing program was to replace all anchors in a support with wedge type anchors, if any of the flush shells were found rejectable. A summary of the testing is excerpted from the report as follows:

ANALYSIS OF DEFECTS FOUND IN REJECTED SUPPORTS
(NOTE: Some hangers have multiple defects)

| | |
|---|---|
| Minimum Wedge Insertion Violated | 2 |
| Baseplate Holes Not Properly Aligned with Anchors* | 22 |
| Excessive Wedge Insertion* | 4 |
| Less than 1/16" Between Shell and Baseplate | 13 |
| Anchor Excessively Out of Plumb* | 1 |
| Holes in Baseplate Oversized* | 14 |
| Failed Pull or Torque Test | 15 |
| Structural Steel vs. Baseplate | 1 |
| As-Bult Incorrect (1 stud too short) (1 stud too long*) | 2 |
| Studs Seized in Shell (DEVCON)** | 4 |
| Shell Damaged (Stripped) During stud Removal* | 2 |
| Inaccessibility for Pull Tests** | 1 |

* Not applicable to structural integrity of stud
** Prevented complete testing - structural integrity - unknown

The following observations were made by the Region III NRC inspector. In total, 629 anchors were involved with a total of 191 baseplates. Two Hundred and Seventy Eight (278) anchors were tested resulting in 69 supports being rejected.

Fifty (50) anchors in the sixty nine (69) rejected supports were found to have defects violating the inspection standards set forth in NRC Bulletin 79-02, Revision b.

This resulted in a 17.9% failure rate of anchors inspected vs. anchors rejected for all QA 1 and "stress" related pipe supports at Enrico Fermi II.

g. Based on the above data, the NRC inspector concludes that:

(1) Testing was accomplished on 278 of 629, or 44%, of the anchor installations.

(2) Depending on how the data is analyzed, a failure rate of 10 to 20% occurred.

(3) Extrapolating test results and assuming a 15% failure rate, approximately 53 of the untested 351 installations may be defective.

This conclusion was discussed with the licensee. In view of the above described testing and results, 100% testing and appropriate action as indicated by test results must be accomplished on all remaining (untested) anchor installations addressed by Bulletin 79-02.

4. Concrete Drilling and Coring

a. 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.

b. The NRC inspector evaluated the scope of work for six site contractors and DECo maintenance, identified as follows: Walbridge Aldinger (Civil); Wismer and Becker (Mechanical and I&C); L. K. Comstock (Electrical and I&C); Chicago Bridge and Iron (Specialized Structural Steel in Reactor Building); Bechtel (Maintenance); and Townsend and Bottum Inc. (Concrete and Mechanical-early on).

c. Typically, drilled holes are provided for the installation of concrete expansion anchors which range in size from 1/4 inch to 1 inch in diameter, and have installation embedment depths of 5/8 inch to 8 inches respectively. Drilled holes partially penetrate the concrete section.

d. In the process of evaluating the drilling program, DECo specification 3071-226, Revision E, "Purchase and Installation of Concrete Anchors at Enrico Fermi Power Plant-Unit 2" and the work procedures of the six previously mentioned site contractors were reviewed. Additionally, Edison design drawings 5C721-2002 and 5C721-2003 were reviewed. Several DDR's representing concrete drilling and coring of all of the site contractors were randomly selected and reviewed. The DDR's all reflected appropriate documentation, dispositioning and signoffs by qualified personnel.

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

5. 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:

a. A Core Drilling Release (CDR) is initiated by the cognizant site contractor. The CDR identifies the civil, mechanical, electrical or the instrument and control design drawings as appropriate. The intent is to identify all internal items (reinforcing steel, conduit, piping, embeds) encased in the proximate concrete region.

b. The CDR is received by the Resident Engineering Office and pertinent data is recorded in the Core Drilling Release log. The document is then routed to each cognizant Principal Resident Engineer for processing.

c. The Resident Engineer reviews the CDR to verify that hole size, hole location and the appropriate design document (DCN, DCR, etc.) authorizing the hole has been provided.

d. With the hole location known, each resident engineer reviews the design drawings for their discipline to identify items encased in concrete, in the region to be drilled. The design drawings which show embedded items are listed on the core drilling release and the release is signed by each Principal Resident Engineer. The release is then signed by the Assistant Director of Field Engineering. The release date is entered in the Core Drilling Release log book, and a copy of the release is filed in the Resident Engineering file.

e. A Cut Bar Request (CBR) is generated, as appropriate. A CBR is a document received from any on-site contractor, and is described in DECo Civil Work Procedures CWP-01 and CWP-04. The request is submitted when a contractor is core drilling a penetration in a concrete member or drilling an anchor bolt hole in a concrete member; and it has been determined that the hole will intersect and cut one or more reinforcing steel bars.

When a CBR is received by the Resident Engineering Office, the secretary enters the request number and date in the cut rebar request log book. The request is then routed to the Principal Resident Civil Engineer for processing.

The resident engineer examines the request form to verify that the following information is provided.

(1) Building and specific location
(2) Reference Civil Design Drawing
(3) Reference Hanger Sketch, as applicable
(4) Hole Size, as required
(5) Hole Location
(6) Depth of Rebar

f. The resident engineer evaluates the request to assess the consequences of cutting the rebar. The assessment is based on the following criteria.

(1) Purpose of the bar (main flexural bar, temperature steel, stirrups, column tie, extra steel around penetrations).

(2) Location of the hole with respect to the concrete member (center span, end span, top of member, bottom of member, side of member).

(3) Total quantity and density of reinforcing steel in the region of the request.

(4) Design alternatives if the bar is not cut.

(5) Consultation with the design engineer for safety related buildings and for other buildings, if required. (Sargent & Lundy, Edison Project Engr.)

g. If the resident engineer determines that the rebar can be cut, the form is signed and dated by the resident engineer indicating approval to cut the bar. The representative of the design engineer also signs and dates this form.

h. If the resident engineer determines that the rebar can not be cut, a notation is made on the cut rebar form indicating disapproval. The form is signed and dated by the resident engineer.

i. When the form is completed by the resident engineer the secretary retains a copy for the Resident Engineering Office file, the date is entered in the cut rebar request log and the document is returned to the originating party.

j. The cut rebar request/report has the report portion completed and transmitted to Field Engineering within two weeks of the date the bar was cut. The Principal Resident Engineer-Arch/Civil, signs in the report section to acknowledge the receipt of the report.

k. A copy of each cut rebar request/report is sent to Troy Engineering-Arch/Civil for final review and approval, when the cut rebar report is complete. These documents are transmitted on a bi-weekly basis.

l. In the event reinforcing bars are inadvertently cut, an NCR is submitted with the Cut Rebar Request/Report.

The coring program at Fermi 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.

Exit Interview

The inspectors met with licensee representatives and others (denoted under Persons Contacted) on July 12, 1984 at the conclusion of the inspection. The inspector summarized the findings, as reported herein, which were acknowledged by the licensee.