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July 11, 1979
AEP:NRC:00162

Donald C. Cook Nuclear Plant Units 1 & 2
Docket Nos. 50-315 & 50-316
License Nos. DPR-58 & DPR-74

Mr. J. G. Keppler,Director
U.S. Nuclear Regulatory Commission, Region III
799 Roosevelt Road
GLen Ellyn, Ill. 60137

Dear Mr. Keppler:

REFERENCE: IE BULLETIN 79-02
PIPE SUPPORT BASEPLATE DESIGNS USING CONCRETE EXPANSION ANCHOR BOLTS DATED 3/8/79; REVISION 1 DATED 6/21/79

This letter and its attachments are in response to the above referenced IE Bulletin No. 79-02, Revision 1, as it applies to Units 1 and 2 of the Donald C. Cook Nuclear Plant. Attachments 1 through 3 contain the individual responses to the questions listed in the bulletin.

As of the date of this letter we have completed the field testing of 100% of the accessible anchor bolts in Unit No. 1 and 82% of the anchor bolts in the containment building of Unit No. 2. Tested plate anchorages which involved failed bolts have been reviewed and repaired as required. Testing of the anchor bolts for Unit 2, outside containment is continuing on a random sample basis during operation.

As a result of the concrete expansion anchor bolt testing and repair program conducted at the Cook Plant we are confident that the bolt failure rate of any given seismic class I system inside containment is below 5%, at a confidence level of 95%. Our field testing procedures, methods and record keeping were inspected by Mr. E. J. Gallagher of NRC, Region III on June 5 - 6, 1979 and the inspection report was issued on June 14,1979 (IE Report No. 50-315/79-12).

Detailed analytical review of seismic category I pipe support plates continues. AEP is a member of the utility group organized by Teledyne Engineering Services (TES). TES developed a generic program which is to be completed and transmitted to us by the end of July, 1979. This generic program was discussed with members of the staff in the NRC offices in Bethesda

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on April 26, 1979. Attachment 4 to this letter contains a status on TES's generic program. Attachment 5 shows our future planned actions and schedules to complete the requirements of the subject bulletin.

Very truly yours,

John E. Dolan

JED:em

John E. Dolan
Vice President

cc: R. C. Callen
G. Charnoff
R. W. Jurgensen
R. S. Hunter
D. V. Shaller-Bridgman

ATTACHMENT 1

RESPONSE TO ITEMS 1 AND 2 OF I.E. BULLETIN NO. 79-02, REVISION 1:

A review of all piping plate supports anchored with concrete expansion anchor bolts in Seismic Category I systems is being performed for both Units 1 and 2 of the Donald C. Cook Nuclear Plant by Teledyne Engineering Services. Please note that in both units mostly wedge type expansion anchor bolts (Hilti Kwik and Phillips Red Head) were used. A small number of shell type anchor bolts were employed. We have issued a qualified procedure for this type of bolts. The original design standard required design loads less than 20% of the ultimate capacity of the bolts and longer embedment lengths than those recommended by the manufacturer. However, the original plate design did not account for plate flexibility in determining the bolt design loads.

Following are summary descriptions of the results of our review up to this point.

DONALD C. COOK UNIT 1

There are approximately 838 Seismic Category I pipe supports in the Unit. A preliminary review of these support plates by Teledyne indicated that 766 base plates were adequately designed and anchored with bolts having a factor of safety (F.S.) higher than 4 (seismic plus operating loading condition). Even though this determination was based on rigid plate theory, it is estimated that the comparatively small loads will only increase by 10 to 15% when plate flexibility is accounted for. Therefore, the bolts in these supports should have a factor of safety of at least 4, using the flexible plate theory.

The remaining 72 pipe supports needed further review to determine the factor of safety of the corresponding bolts. For those base plates inside containment, inaccessible during normal operation,a conservative reanalysis was done by an outside consultant, EDS Nuclear Inc.,and the required modifications have been implemented.

Once the Teledyne generic program is completed by the end of July,1979, the results of such program, together with the actual testing results, will be used as the basis for a detailed analysis to determine the actual factor of safety of individual bolts on the plate supports of concern. This analysis will utilize flexible plate theory where required. The modifications to meet a factor of safety of four will be made, as needed, after the completion of the analysis.

DONALD C. COOK UNIT 2

Teledyne is reviewing the base plate support designs, for Seismic Category I piping systems. Particular details of the review will be available in the near future.

However, the corresponding Unit 2 pipe support plates to those that were reanalyzed and modified in Unit 1 Containment were also reviewed. A limited number of modifications on Unit 2 have been implemented to insure that the minimum factor of safety in any bolt for seismic plus operating loading conditions inside the containment is at least two. The Unit refueling period is currently scheduled to start in October - November of 1979. We expect to be able to define by then all the modifications needed to bring the bolts' factor of safety to a value of four. Completion of testing outside containment and detailed reanalysis incorporating both flexible theory and "as-built" bolt conditions are required before such modifications are designed and implemented.

The initial plate support classification, the followup reanalysis and the design of the necessary modifications, for both Units 1 and 2, will be completed as soon as possible after the results of the Teledyne generic program become available. These results will include the effect of plate rigidity and shear-tension interaction behavior. The reanalysis will be done using the ANSYS finite element program, jointly by Teledyne and AEPSC. Teledyne has completed the pre and post-processor incorporating the NRC Staff recommendations, for the ANSYS program. Our design criterion will be to provide a factor of safety of four for all anchor bolts. The description of the computer program and the analytical model will be submitted in the future as part of our response describing the results of the reanalysis program.

ATTACHMENT 2

RESPONSE TO ITEM 3 OF I.E. BULLETIN NO. 79-02, REVISION 1

In our original design criteria the effect of cyclic loads was not included as a separate criterion for expansion anchor bolt design. The design safety factor of four or more was considered sufficient margin for cyclic loads. Design data on bolt strength against cyclic loads were not and are not available from the bolt manufacturers.

Teledyne, as a part of the generic program, is conducting full scale tests on bolts to determine the effect of cyclic loads on the static capability of the anchor bolts. It is our belief that if the bolts are installed as per the manufacturer's recommended procedure and if the bolts can attain the intended ultimate capacity then it follows that the bolts will resist the cyclic loads safely. We anticipate that the Teledyne test results will support this criterion. However, upon completion of the generic program by Teledyne, our design criterion on cyclic loads will be evaluated and sent to the NRC as part of our final response.

ATTACHMENT 3

RESPONSE TO ITEM 4 OF I.E. BULLETIN NO. 79-02, REVISION 1

Even though a formal set of QC documents does not exist to support the original installation of the bolts, it is the recollection of the parties involved at the time, that routine visual surveillance was exerted and that the bolts were correctly installed. However, since enough QC documentation was not available to properly respond to the subject bulletin requirements, Indiana and Michigan initiated the testing of anchor bolts in May, 1979. The field testing consists of:

a) checking the specified design size and type

b) determining the bolt embedment length

c) verifying setting load equal to four times the allowable design load as specified in test procedures. The testing used was direct pull test and by use of Schnorr Disc-Washers (Belville Type) where access was limited.

The following are the test results for both Units of the Donald C. Cook Nuclear Plant. These results are presently being reviewed.

Unit 1

Testing of the anchor bolts was started in May and was completed by June 15, 1979. We have tested 100% of all the accessible (96.7% of total) bolts. The failure rate in the containment was 7.4%, in the auxiliary building 7.4%, and 6% in the turbine building. All the tested plate anchorages which involved failed bolts have been reviewed and repaired as required inside containment. Repairs outside the containment are in progress.

Unit 2

About 82% of the bolts were tested in the containment. The overall failure rate was 4.4%. All pipe support plate containing failed bolts have been reviewed and repaired. Therefore, we believe that the failure rate is now below 5% at the 95% confidence level in any seismic category I system.

Testing outside the containment is in progress. This testing will be done on a random sample basis so as to insure that the failure rate is reduced to below 5% at the 95% confidence level. We expect to complete this testing by August 10, 1979. Details of the testing results will be transmitted to the NRC in our final response.

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ATTACHMENT 4

June 29, 1979
3501-33

AEP:NRC:00162

To: Distribution

Subject: Status Report - Generic Program Baseplate/Expansion Anchor Studies

As the generic program nears completion, TES is taking this opportunity to summarize the essentials of the program and give a brief status report.

BACKGROUND

In April of this year several utilities joined together to sponsor an analytical and experimental investigation of pipe support baseplates for Seismic Category I piping. This became known as the "generic program" and its function is to provide supportive data and an analytical tool to the utilities to assist them in their responses to NRC IE Bulletin 79-02. Since all of the utilities were affected by the bulletin in a similar way, it was felt that generic studies would benefit the utilities in their plant specific investigations. Many of the plants involved use similar anchor bolts and baseplate configurations.

The utilities required anchor bolt test data for shear-tension interaction and cyclic loadings which are not currently available or which are only partially available. Also, an efficient procedure for analyzing baseplates accounting for plate flexibiity was also required. The generic program addresses both of these requirements.

ANALYTICAL WORK

It is recognized that the finite element method is the most versatile method of analyzing baseplates accounting for plate flexibiity in addition to nonlinearities such as gapping and variable bolt stiffness. Hence, TES has developed a pre- and postprocessor to the commercially available ANSYS computer code. A complete finite element model of a baseplate, concrete subgrade, anchor bolts, and attachment consisting of any rolled shape may be input in only five punched cards. The postprocessor reduces the output and summarizes bolt loads and plate stresses. Revision B of the program has been issued and it includes geometry plot capability, averaging of plate bending stresses and the option to add or delete bolts and concrete spring elements in addition to several other enhancements.

The pre- and postprocessor has been verified analytically using standard ANSYS analyses. Also, four-bolt and eight-bolt experimental baseplates have been constructed and instrumented to compare results with the pre-

and postprocessor. The four-bolt plate experiment has been completed and the results compare favorably with the computer program.

Utilities are now using Revision B of the pre- and postprocessor program.

Curves of bolt load versus plate thickness have been generated for typical baseplates and bolts.

SHEAR-TENSION INTERACTION TESTS

These destructive tests which determine ultimate tension and shear loads for expansion anchors are underway because of the lack of available data. Our objective is to provide shear-tension interaction diagrams which are less conservative than the linear interaction equation for shear and tension. Several size anchors from seven different manufacturers are being tested. Five points on the shear-tension interaction curve will be tested for each size and type of anchor. There are four tests for each point and the total number of tests is about 700. Sixty-six unreinforced slabs measuring 3 1/2 ft x 7 ft x 1 ft depth were poured with 3000 psi concrete for these experiments.

A test fixture has been constructed using two hydraulic jacks which are controlled simultaneously with a specially designed electronic feedback system. The desired ratio of shear and tension forces are carefully controlled by this system. The static loading takes about one minute to complete. Load versus deflection and tension versus shear force are plotted automatically during each test.

Testing is about 20% complete. Our projected finish date for shear-tension interaction tests is July 15.

CYCLIC TESTS

Mostly 3/4-inch expansion anchors, representative of those in the plants, are tested cyclically. An MTS electrohydraulic machine is used for this experiment. Anchors are placed in one foot concrete cubes and cycled in tension. A low cycle test at 3 Hz for 1000 cycles is performed with a load range of 12.5% of the static capacity. Also a high cycle test at 80 Hz for one million cycles is performed with a load range of 6.5% of the static capacity. After each cyclic test, the bolt is examined for damage and axial deflection. Then the bolt is tested statically to its ultimate load. Hence, the effect of cyclic load on static capacity is determined.

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Most of the low cycle tests have been completed and the high cycle tests are getting underway. Completion is anticipated by July 15.

Please contact TES if we may answer any questions.

Very truly yours,

TELEDYNE ENGINEERING SERVICES

Raymond Ciatto

Raymond D. Ciatto
Principal Engineer

RDC:jej

ATTACHMENT 5

FUTURE PLANS AND SCHEDULES FOR COMPLETION

Complete bolt testing - Unit 2		August 10, 1979
Final classification of base plates that require further analysis	-Unit 1	July 16, 1979
	-Unit 2	July 31, 1979
Completion of reanalysis including flexible plate theory and as built data	-Units 1 & 2	September 15, 1979
Design of necessary fixes (if needed)	-Unit 1	October 20, 1979
	-Unit 2	October 1, 1979
Field modifications (if needed)	-Unit 1	By the end of fourth refueling May, 1980 (approximately)
	-Unit 2	By the end of first refueling December, 1979 (approximately)