TIC

Southern California Edison Company

P. O. BOX 800
2244 WALNUT GROVE AVENUE
ROSEMEAD, CALIFORNIA 91770

K. P. BASKIN
MANAGER, GENERATION ENGINEERING

TELEPHONE
213-572-1401

July 8,1979

U. S. Nuclear Regulatory Commission
Region V
Suite 202, Walnut Creek Plaza
1990 N. California Boulevard
Walnut Creek, California 95696

Attention: Mr. R. H. Engelken

Gentlemen:

Subject: IE Bulletin Nos. 79-02 and 79-02, Rev. 1
Docket Nos. 50-361 and 50-362
San Onofre Nuclear Generating Station
Units 2 and 3

Your letters of March 8 and June 21, 1979 forwarded IE Bulletin Nos. 79-02 and 79-02, Revision 1, "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts", and requested specific information on the seismic analysis of Seismic Category I piping systems.

Attached, in response, are two reports (Attachments A and B) from the San Onofre Units 2 and 3 A/E (Bechtel) which address the specific concerns of both bulletins on an item-by-item basis as applicable.

Should you have any questions or require further clarification, please contact me.

Very truly yours,

K P Baskin/NH

Enclosure
cc: U. S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, D. C. 20555

958115

7909180142

Q

79-109

ATTACHMENT A

A Report on

PIPE SUPPORT BASE PLATE DESIGNS

USING CONCRETE EXPANSION ANCHOR BOLTS

(In Response to: NRC IE Bulletin No. 79-02, March 8, 1979)

I. Introduction

This report is in response to NRC IE Bulletin 79-02, dated March 8, 1979, requiring all licensees and permit holders for nuclear power plants to review the design and installation procedures for concrete expansion anchor bolts used in pipe support base plates in systems defined as Seismic Category I by the NRC Regulatory Guide 1.29, "Seismic Design Classification", Revision 1, dated August, 1973 or by the applicable SAR.

As a preface to our response we would like to clarify the San Onofre Units 2 & 3 project position on the use of concrete expansion anchor bolts. Concrete expansion anchor bolts are not permitted for use in Seismic Category I ASME code class lines 2-1/2 inch in diameter or larger. Supports for these lines incorporate the use of cast in place embedments, through wall bolts, or William's Rock Bolts, a drilled in place, grouted anchor bolt. Concrete expansion anchor bolts are approved for use in non-ASME Seismic Category I piping systems or in 2 inch and smaller ASME Seismic Category I systems.

The design and installation of the expansion anchor bolts on the San Onofre Nuclear Generating Station, Units 2 & 3 project are governed by the following documents:

a. Construction Specification CS-C8, Design, Installation and Testing of Concrete Expansion Anchors

b. Construction Specification CS-C13, Limitations on Drilling in Concrete and Masonary Structures

c. Work Plan Procedures/Quality Control Instructions WPP/QCI No. 011, Installation of Concrete Expansion Anchors

d. Work Plan Procedures/Quality Control Instructions WPP/QCI No. 023, Concrete and Masonary Drilling

II. Response to Action Items

The following text provides a response to each item of IE Bulletin 79-02 as it applies to the use of concrete expansion anchor bolts for the support of Seismic Category I piping system allowed by project criteria:

1. Verify that pipe support base plate flexibility was accounted for in the calculation of anchor bolt loads. In lieu of supporting analysis justifying the assumption of rigidity, the base plates should be considered flexible if the unstiffened distance between the member welded to the plate and the edge of the base plate is greater than twice the thickness of the plate. If the base plate is determined to be flexible, then recalculate the bolt loads using an appropriate analysis which will account for the effects of shear-tension interaction, minimum edge distance and proper bolt spacing. This is to be done prior to testing of anchor bolts. These calculated bolt loads are referred to hereafter as the bolt design loads.

Response

The basis for pipe support design for the San Onofre project is specified in the San Onofre Units 2 & 3 "Pipe Supports Civil/Structural Criteria and Procedures" and utilizes the flexible base plate concept. The resulting concrete expansion anchor tensile loads, due to moment, are calculated by positioning the centroid of the compressive area at the compression flange of the pipe support member attached to the base plate. For direct tensile loads, the load is proportioned by the inverse of the distance from the expansion anchor to the centroid of the pipe support member. The total tensile loads on a given expansion anchor is then taken as the sum of the two tensile loads. Since the allowable value for shear and tension are

the same, shear-tension interaction is calculated by the linear sum of the shear and tension and must be equal to or less than the allowable design value of the selected expansion anchor.

2. Verify that the concrete expansion anchor bolts have the following minimum factor of safety between the bolt design load and the bolt ultimate capacity determined from static load tests (e.g. anchor bolt manufacturer's) which simulate the actual conditions of installation (i.e., type of concrete and its strength properties):

a. Four - For wedge and sleeve type anchor bolts,

b. Five - For shell type anchor bolts.

Response

a. Utilizing the manufacturer's static test data for wedge anchors with a concrete strength of fc' = 4000 psi, the allowable design values specified in the project design criteria for 1/2" and 1" diameter wedge anchors satisfy the factor of safety of four criteria. However, for 5/8" and 3/4" diameter wedge anchors, the factors of safety would be 3.72 and 3.74 respectively when comparing the manufacturers static test data for a concrete strength of fc' = 4000 psi with the project specified allowable design values. A review of the project concrete cylinder test data for the class of concrete with a specified design strength of fc' = 4000 psi indicates that the average 28 day concrete strength for 3438 concrete cylinders tested was fc' = 5409 psi. Using this strength as representative of the actual concrete strength, it is found that the 5/8" wedge anchors would meet the factor safety of four criteria while the 3/4" wedge anchors would have a factor of safety of 3.88. Sleeve anchors are not used for pipe supports.

958118

b. For shell anchors a factor of safety of five is satisfied when comparing the manufacturer's static test data for concrete strengths of fc' = 4000 psi with the project specified allowable

design values.

3. Describe the design requirements if applicable for anchor bolts to withstand cyclic loads (e.g. seismic loads and high cycle operating loads).

Response,

In the design of the piping systems consideration is given to deadweight, thermal, seismic (inertia and anchor movement), and dynamic loads (including water hammer in the feedwater and steam hammer in the main steam systems) in the generation of the static equivalent pipe support design loads. To the extent that these loads include cyclic considerations, these effects would be included in the design of the hangers, base plates and anchorages.

The safety factors used for concrete expansion anchors, installed on supports for safety related piping systems, were not increased for loads which are cyclic in nature.

The use of the same safety factor for cyclic and static loads is based on the FFTF Tests*. The test results indicate:

a. The expansion anchors successfully withstood two million cycles of long term fatigue loading at a maximum intensity of 0.20 of the static ultimate capacity. When the maximum load intensity was steadily increased beyond the afore-mentioned value and cycled for 2,000 times at each load step the observed failure load was about the same as the static ultimate capacity.

b. The dynamic load capcity of the expansion anchors, under simulated seismic loading, was about the same as their corresponding static ultimate capacities.

*Drilled - In Expansion Bolts Under Static and Alternating Loads, Report No. BR-5853-C-4 by Bechtel Power Corp., January 1975.

4. Verify from existing QC documentation that design requirements have been met for each anchor bolt in the following areas:

   a. 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.

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

Response

a. Anchor bolt preload is accomplished by using the installation torque value for the specified concrete anchor. The preload is greater than the design allowable for a specified anchor. Shell anchors are only installed in floor mounted installation and all floor mounted base plates have a minimum of 3/4" grout under the base plate thereby eliminating the possibility of the shell bearing on the plate. As a further precaution, QC documentation is currently being modified to require a visual verification of no contact prior to the grouting operation. Installation testing is accomplished prior to the placement of grout and is accomplished by personnel other than the installers.

b. The project Work Plan Procedure/Quality Control Instructions which govern the installation and testing of concrete expansion anchors requires that all Seismic Category I expansion anchors be inspected to assure that specification requirements have been satisfied. The QC inspection verifies the size of anchor, the type of anchor, the embedment depth, the center to center spacing and the minimum edge distance. In addition, a minimum of 10 percent of all Seismic Category I concrete expansion anchors are torque tested to ensure that preload requirements are satisfied. This data is recorded on a Construction Inspection Data Report and is filed at the Southern California Edison's Document Control center at the site.

III. Conclusions

Concrete expansion anchor bolts are only approved for use in non-ASME Seismic Category I piping or in 2 inch and smaller ASME Seismic Category I piping. Current project design procedures properly account for base plate flexibility when establishing expansion anchor design loads. Adequate factors of safety have been incorporated into the specified allowable loads. Existing QC procedures adequately document that specified installation requirements have been satisfied. Documentation is on file at the jobsite.

ATTACHMENT B

Supplementary Input to Report on Pipe Support Base Plate Design Using Concrete Expansion Anchor Bolts

(Response to: NRC IE Bulletin No. 79-02, Rev. 1 June 21, 1979)

The following text provides supplementary input in response to IE Bulletin 79-02 and addresses new issues identified in Revision 1 of the bulletin dated June 21, 1979. The referenced item numbers related directly to item numbers in that document. No response is provided herein to items in the revised IE Bulletin which were already addressed in our previous response.

2. ....The bolt ultimate capacity should account for the effects of shear-tension interaction, minimum edge distance and proper bolt spacing.....

Response

The allowable design loads were established on the basis of a specified minimum edge distance and center to center spacing to preclude overlap of the pullout/shear cone with the edge of the concrete surface and/or adjacent bolts. Reductions in the minimum center to center spacing are allowed provided that the allowable design load is reduced in the same proportion. The maximum permitted reduction in center to center spacing is limited to 50 percent of the specified value. The method for considering shear-tension interaction is already discussed in the response to item 1.

4. ....The preferred test method to demonstrate that bolt preload has been accomplished is using a direct pull (tensile test) equal to or greater than design load. Recogniz'ng this method may be difficult due to accessibility in some areas an alternative test method such as torque testing may be used. If torque testing is used it must be shown and substantiated that a correlation between torque and tension exists. If manufacturer's data for the specific bolt used is not available, or is not used, then site specific data must be developed by qualification tests.....

Response

The specified installation torque values were established utilizing a combination of manufacturer's data and industry standards for the relationship between torque and bolt tension. A range is specified for the installation torque to accommodate variability in the friction characteristics between the bolt threads, nut and washer.