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June 11, 1982

Mr. R. H. Engelken, Regional Administrator
Office of Inspection and Enforcement
Region V
U.S. Nuclear Regulatory Commission
1450 Maria Lane, Suite 260
Walnut Creek, CA 94596

Re: Docket No. 50-275, OL-DPR-76
Docket No. 50-323
Diablo Canyon Units 1 and 2
Pipe Supports Base Plate Design--IEB-79-02

Dear Mr. Engelken:

Your letter dated February 5, 1982, requested additional information related to I&E Bulletin 79-02. PGandE interim response dated March 12, 1982 provided you with a brief status report and an outline of our planned action. The enclosed information is our final report and represents our closing response for Unit 1. A separate final report will be provided for Unit 2 by February 15, 1983.

Very truly yours,

Philip A. Crane, Jr.

Enclosure

cc: Service List

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ENCLOSURE

PACIFIC GAS AND ELECTRIC

DIABLO CANYON UNIT 1

FINAL REPORT ON RESOLUTION OF OPEN ISSUES FROM I&E BULLETIN 79-02

NOTE: The numbers below correspond to the paragraphs as listed in Attachment 1 to the NRC letter dated February 5, 1982. These paragraphs represent areas where additional information is required by NRC-Region V Staff after review of PGandE's previous responses to the bulletin. The NRC questions are single spaced and indented.

Bulletin Paragraph 1:

> Verify pipe support base plate flexibility was accounted for in the calculation of anchor bolt loads. A description of the analytical model used is to be submitted.

Additional Information Required by NRC Region V:

1) Notification of completion of modifications for Unit 1.

2) Notification of completion of analysis and modifications for Unit 2.

PGandE RESPONSE:

1.1 Completion of Modifications for Unit 1

Completed. Refer to PGandE letter dated March 12, 1982.

1.2 Completion of Modifications and Analysis for Unit 2

In progress. This item will be addressed in the Final Report for Unit 2.

Bulletin Paragraph 2:

Verify minimum anchor bolt factors of safety have been achieved.

Additional Information Required by NRC Region V:

Current status of Unit 2 modifications.

PGandE RESPONSE

2.0 Current Status of Unit 2 Modifications

In progress. This item will be addressed in final report for Unit 2.

Bulletin Paragraph 3:

Describe the design requirements for cyclic loads.

Additional Information Required by NRC Region V:

None.

PGandE RESPONSE

3.0 Design Requirements for Cyclic Loads

No additional information required.

Bulletin Paragraph 4:

Verify from existing QC documentation or from a sampling testing program that anchor bolts are preloaded and are properly installed.

Additional Information Required by NRC Region V:

1) For stud type anchors - Verification, from existing QC documentation or from a sampling testing program, that stud type anchors installed prior to August 1977 are preloaded to design load and are properly installed (correct embedment depth, torque, etc.).

2) For shell type anchors - a numerical quantification of the term "almost exclusively," and an assessment of the stripping strength factors of safety achieved at Diablo Canyon for shell type anchors.

PGandE RESPONSE

4.1(a) Anchor Bolt Preload

We have tested a random sample of stud-type expansion anchors to identify the existing preload on anchors which lacked documentation of the installation torque.

The testing was performed using the torque-wrench method with applied torque values derived from our torque-tension correlation tests submitted as Attachment II to our December 3, 1980 submittal.

The test results indicate that part of the preload is lost within a few days after the application of the installation torque. However, initial test data show that a preload does remain. This is generally on the order of 50% of the design

load. Other utilities and architect-engineers have documented similar findings:

A. Testing performed by the Bechtel Power Corporation for the Fast Flux Test Facility (FFTF) facility and documented in their generic response to the I&E Bulletin 79-02, concluded that some preload is lost over the life of the plant due to creep and other similar phenomena.

B. The TVA generic response to IEB 79-02 (July 5, 1979), based on their investigation for six of their power plants, concludes:

". . . All anchor systems exhibit a short term installation stress loss of 25 to 30 percent during the first day or two following installation and a permanent stress of approximately 50 percent . . ."

Furthermore, cyclic load tests performed to date have not identified that preload on stud-type expansion anchors is necessary to assure design capacity under cyclic load conditions:

a. Testing and analysis performed by Teledyne Engineering Services, documented in Part IV of Attachment II to our December 3, 1980 submittal, concluded:

". . . The important generic findings of this program are:

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

b. Testing performed by the Bechtel Power Corporation for the FFTF and documented in their generic response to NRC I&E Bulletin 79-02, concluded:

". . . The [FFTF] test results indicate:

1. 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 aforementioned value and cycled for 2,000 times at each load step, the observed failure load was about the same as the static ultimate capacity.

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

and continued:

". . . It is not necessary that the bolt preload be equal to or greater than the bolt design. Pipe supports and anchors are subjected to static and dynamic loads. The dynamic loads are seismic loads which are short duration cyclic loads. This type of cyclic load is not a fatigue load, so the amount of preload

on the bolts will not greatly affect the performance of the anchorage . . ."

". . . Therefore, if the initial installation torque on the bolt accomplishes the purpose of setting the wedge, then the ultimate capacity of the bolt is not affected by the amount of preload present in the bolt at the time of cyclic loading . . .".

C. Paragraph 4 of Draft Regulatory Guide MS 129-4, "Anchoring Component and Structural Supports in Concrete", states:

". . . It has been argued that a large amount of preload on expansion anchors (particularily, shell anchors) is not necessary. In order to assess the related merit of having a designated amount of preload on expansion anchors, the NRC staff has undertaken a research program to evaluate the effects of various amounts of expansion anchor preload.

At present, the results of the research program are not available. When the research is completed, full consideration will be given to establishing better preload ranges for expansion anchors . . ."

For these reasons we have discontinued our preload testing program, and we intend this to be our closing response on this subject. Should the results of the research program undertaken by the NRC

staff, as described in the Draft Regulatory Guide MS 129-4, load to new conclusions, we will respond appropriately.

4.1.(b) Embedment Depth

We have ultrasonically tested the embedment depth of stud-type anchors installed before August 1977. It was determined, with a 95% confidence level, that more than 95% of the installed anchors meet the minimum embedment depth recommended by bolt manufacturers.

Since the actual load of a bolt is quite often much lower than its allowable load, it is reasonable to assume that a substantial portion of the studs identified as not meeting the minimum embedment requirements comply with design load safety factors.

Documentation of the test procedure and test results are available at the construction site for inspection.

4.2.(a) Numerical Quantification of "Almost Exclusively"

We have reviewed our quality control records for shell-type and stud-type expansion anchors used at Diablo Canyon before 1977. Our record shows that 96% of the concrete expansion anchors used with seismic category I pipe supports were of the shell-type and 4% were of the stud-type.

The records of this inventory are available at the construction site for inspection.

4.2.(b) Stripping Strength

We have tested the stripping strength of four threads of bolt engagement for both the Hilti and Phillips shell-type expansion anchors used to attach seismic category I pipe supports to concrete. The test results show that all of the tested shell type anchors were able to sustain a proof load greater than or equal to 5 times the allowable design loads as given in the PGandE design criteria.

The test procedure and results are enclosed as Attachment 1.

Bulletin Paragraph 5:

Determine the extent that expansion anchors were used in concrete block walls.

Additional Information Required by NRC Region V:

None.

PGandE RESPONSE

5.0 Extent of Usage for Expansion Anchors

No additional information required.

B. General Test Procedure

The bolts were engaged four threads in the shells as follows: the threads of each bolt were marked with an ink line parallel to the bolt axis. The bolt was engaged in the shell so that the threads gripped and then backed out until it became disengaged from the shell. At this point the ink line on the bolt threads was continued onto the shell thus establishing a reference point from which thread engagement could be determined. The bolt was then engaged four complete revolutions as measured with the reference marks.

The bolt and shell assemblies were installed in the testing machine as shown in Figure 1. The bolt heads were gripped by the test fixture while the shell anchors were installed in the jaws of the testing machine with attention given that the entire internally threaded portion of the shell anchor was above and clear of the jaws.

Once installed each bolt and shell assmebly was loaded in pure tension until the required load was reached or the threads stripped.

TEST RESULTS

The test data is tabulated on page 2 of the attached Central Coast Laboratories report.

All of the tested shell type anchors were able to sustain a proof load greater than or equal to 5 times the allowable design loads as given in the P G and E Design Criteria Memorandum M-9.

	Hilti		Phillips	
Size	Proof Load	Pd X 5*	Proof Load	Pd X 5*
1/2	6,750	6,545	8,500	8,500
5/8	9,700	9,390	11,700	11,700
3/4	16,050	15,495	16,200	16,200
7/8	-	-	17,850	17,850

\- Anchors not available in this size and brand
* concrete = 3,850 psi

CONCLUSION

The results of this test confirm that thread engagement of four threads in shell type concrete anchors is not a limiting factor in the anchoring capacity of these anchors and is sufficient to provide safety factors of 5 above the allowable design loads.

The results are as follows:

Sample No.	Anchor Manufacturer	Anchor Size (Dia/In)	No. of Threads Engaged	Required Load(lbs)	Pass/ Fail
S-267-82	Hilti	1/2	4	6750	Pass
S-268-82	Hilti	1/2	4	6750	Pass
S-269-82	Hilti	1/2	4	6750	Pass
S-270-82	Phillips	1/2	4	8500	Pass
S-271-82	Phillips	1/2	4	8500	Pass
S-283-82	Phillips	1/2	4	8500	Pass
S-272-82	Hilti	5/8	4	9700	Pass
S-273-82	Hilti	5/8	4	9700	Pass
S-284-82	Hilti	5/8	4	9700	Pass
S-286-82	Phillips	5/8	4	11700	Pass
S-287-82	Phillips	5/8	4	11700	Pass
S-288-82	Phillips	5/8	4	11700	Pass
S-274-82	Hilti	3/4	4	16050	Pass
S-275-82	Hilti	3/4	4	16050	Pass
S-276-82	Hilti	3/4	4	16050	Pass
S-280-82	Phillips	3/4	4	16200	Pass
S-281-82	Phillips	3/4	4	16200	Pass
S-282-82	Phillips	3/4	4	16200	Pass
S-277-82	Phillips	7/8	4	17850	Pass
S-278-82	Phillips	7/8	4	17850	Pass
S-279-82	Phillips	7/8	4	17850	Pass