

RESULTS OF INSPECTION AND TESTING PROGRAM

IN RESPONSE TO

NRC IE BULLETIN 79-02 AND ITS REVISIONS

(FOR INTERIM PLANT OPERATION)

FOR

CONSUMERS POWER COMPANY

PALISADES NUCLEAR PLANT

SOUTH HAVEN, MICHIGAN

8002200400

INSPECTION AND TESTING PROGRAM  
 NRC IE BULLETIN 79-02 AND ITS REVISIONS  
 CONSUMERS POWER COMPANY  
 PALISADES NUCLEAR PLANT

1. GENERAL

An inspection and testing program is currently being performed at the Palisades nuclear plant to fulfill the requirements of NRC IE Bulletin 79-02 and its revisions for safety seismic pipe supports using concrete expansion anchor bolts.

The program consists of pull-testing the concrete expansion anchor bolts at 200% of their design allowables and verification of installation parameters such as shoulder-to-cone dimensions, protrusions, thread engagements, base plate hole sizes, and edge distances. This inspection and testing program was also discussed and agreed upon in meetings between the NRC, CPCo, and Bechtel in Chicago and Washington D.C., on October 26 and November 21, 1979, respectively.

2. INSPECTION AND TESTING STATUS

The following is a summary of inspection and testing completed for safety seismic piping supports for piping 2-1/2 inches and larger as of January 29, 1980.

	<u>Containment</u>	<u>Auxiliary Building and Other</u>
A. <u>Expansion Anchor Bolts</u>		
1) Inspected and tested	634 (348)*	903 (290)*
2) Inaccessible	98 (69)*	69 (26)*
3) Failures		
a) Shell type (pull test)	2	14
b) Wedge type (pull test)	1	-
c) Inspection	(2)*	(3)*

\*As of January 9, 1980

	<u>Containment</u>	<u>Auxiliary Building and Other</u>
B. Base Plates		
1) Total number of base plates involved	246	691
2) Number of base plates inspected	186 (178)*	184 (144)*

3. SUMMARY OF INSPECTION AND TESTING RESULTS

A total failure of 17 out of 1,537 available anchors tested indicates an acceptable rate of failure to ensure a required 95% confidence level. Therefore, further pull testing of concrete expansion anchors has been terminated.

Approximately 72% of all shell anchors inspected meets the shoulder-to-cone and protrusion acceptance criteria. An adequate thread engagement existed in 88% of the bolts. Fourteen percent of the base plates inspected had oversized holes (greater than one bolt head). However, all such anchors or base plates which did not meet the engineering acceptance criteria were reset or repaired during the inspection and testing program as specified. Approximately 11% of supports were found to be inaccessible because of high radiation areas or physical congestion. The above percentage information is based on the data available as of January 9, 1980.

4. SUMMARY OF SITE-SPECIFIC TESTING RESULTS

Site-specific tests were conducted on shell and wedge type anchors to establish the following:

A. TORQUE-TENSION RELATIONSHIPS

Torque-tension results indicate a confirmation of reinstallation torque values as specified and provide an average tension values in excess of two times the allowable design load for all anchors.

B. RELAXATION TESTS

Relaxation losses were found to vary from 12 to 50% with an average of 26% over a 2-week period. Further relaxation is not expected because other tests (on wedge anchors) indicate that nearly all relaxation losses occur within the first 7 days after torquing.

\*As of January 9, 1980

C. ULTIMATE CAPACITIES

The data from the ultimate strength tests on partially expanded anchors produced definitions of acceptance criteria for shoulder-to-cone dimensions.

5. INSPECTION AND TESTING PROGRAM FOR PLANT OPERATION

The following program is currently being performed to complete inspection and testing inside the containment and inaccessible areas outside the containment for pipe sizes 2-1/2 inches and larger under normal plant operating conditions.

- A. Further pull testing is being discontinued. However, each anchor will be tested because there will be a reinstallation torque.
- B. All base plates, bolts, and expansion anchors will be inspected to conform with engineering acceptance criteria. These include shoulder-to-cone measurements and resetting, if required.
- C. If inspection (with appropriate analysis) shows that installation does not meet acceptance criteria, modifications will be made.

6. BASIS FOR INTERIM PLANT OPERATION

To provide a basis for interim operations, the data from the completed testing and inspection program for large and small piping supports are used to assess the condition of the remaining population of anchors installed at the Palisades plant as described below in Sections 7 and 8.

7. LARGE PIPING SUPPORTS (2-1/2 INCHES AND LARGER)

A. TESTING

As indicated in Section 3, a total failure of 17 out of 1,537 available anchors pull tested provides an acceptable rate of failure to ensure a required 95% confidence level for the remainder of the anchor population installed at the Palisades plant.

B. INSPECTION PARAMETERS

1) Shoulder-to-Cone Dimensions and Protrusions

Twenty-eight percent of the total number of shell anchors inspected did not meet the shoulder-to-cone and protrusion acceptance criteria. The ultimate strength tests conducted at the Palisades plant on partially expanded shell anchors indicate

that these anchors retain a significant portion of their average ultimate strengths for varying degrees of expansion even outside of the acceptance criteria limits. This indication was also confirmed by the fact that these same anchors that did not meet the shoulder-to-cone acceptance criteria did withstand a pull test load equal to a minimum of 200% of the anchors' allowable design loads.

Based on the above trend, 72% of the remaining shell type anchors installed at the Palisades plant should meet the shoulder-to-cone acceptance criteria. The shoulder-to-cone acceptance criteria ensure that an anchor is capable of withstanding an average ultimate load of at least five times the allowable design load based on the ultimate strength tests conducted at the Palisades plant. The remaining 28% of the anchor population would have a minimum strength exceeding 200% of the allowable design loads based on the proof load tests (200% pull tests). Thus, shell type anchors installed at the Palisades plant have a minimum safety factor of two or more with at least a 95% confidence level.

## 2) Oversized Holes

Results of inspection showed that only 14% of the base plates were found to have holes larger than a bolt head. These oversized holes apparently were made to permit fit-up for support base plate installation. According to known facts, plate washers were installed over these holes which would ensure transfer of load between the bolt and the plate. In 93.5% of the cases (of the 14% indicated above), these anchor bolts had calculated safety factors of much in excess of two. Nevertheless, all of the base plates inspected having oversized holes have been repaired, and repairs will be made for the remaining population of similar base plates as a part of the inspection and testing program during the plant operation.

## 3) Thread Engagement

Twelve percent of the bolts did not meet the thread engagement acceptance criteria. However, all of these bolts had an excess of three threads which will provide a safety factor of at least five, based on ultimate strength. As a part of inspection and testing during a plant operation, all such bolts not meeting the thread engagement acceptance criteria will be replaced or reinstalled.

4) Miscellaneous Anchor Bolt Removal

Approximately 47 (7.4%) of a total of 638 anchors (as of January 9, 1980) were replaced without pull testing because of various reasons. A detailed review of completed data sheets was made to determine if some of these anchor bolts would have failed if they had been subjected to a pull test. It is conservatively estimated that five of them probably would have failed based on examination of various inspection parameters.

C. FACTORS OF SAFETY

1) Calculated Support Loads

The ultimate capacity of existing pipe support anchor bolt sizes was compared with the calculated support loads. In 91.5% of the cases (a total of 514 anchors analyzed), the factors of safety were found to be equal to two or more. Further detailed analyses on those supports having safety factors of less than two are in progress. The results to date indicate that the calculated safety factors will be in excess of two. Based on this, it is expected that the remaining population of anchor bolts will have a safety factor of two or more.

2) Calculated Support Loads Versus Test Load

In those cases where the anchors were tested successfully to 200% of their allowable design loads irrespective of their shoulder-to-cone dimensions, the factors of safety will be calculated using the 200% test load as the ultimate capacity.

3) Inaccessible Supports

A total of 11% (167) of the supports were reported to be inaccessible for testing because of high radiation areas or physical congestion. In all evaluated cases for which the design loads and as-built information were available to date (15% of 11%), the safety factors were well over five.

D. SUMMARY

A comprehensive review of testing and inspection parameters as described above indicates that a minimum safety factor of two will be met for the remaining population of anchor bolts installed at the Palisades plant.

Out of a total of 638 anchors, 17 anchor bolts failed the pull test equivalent of 200% of the allowable design criteria. An additional five anchors are conservatively included as failures as mentioned in Subparagraph 7.B.4. A total failure of 22 provides a required confidence level of 95%; that is, no more than 5% of the anchors installed at the Palisades plant are defective for the remaining population of anchors.

8. SMALL PIPING (2 INCHES AND SMALLER)

A. TESTING

A total of 33 available small pipe supports have been inspected and tested as of January 29, 1980. Out of a total of 58 shell anchors, none failed the pull test, equivalent to 200% of their allowable design loads. This provides an acceptable 95% confidence level that no more than 5% of the bolts are defective in the remaining population of anchor bolts.

B. INSPECTION PARAMETERS

Inspection of base plates and anchor bolts indicates generally a similar trend of installation parameters (such as oversized holes, shoulder-to-cone dimensions, and thread engagements as that described above for large piping).

C. FACTORS OF SAFETY

The ultimate capacity of existing pipe support anchor bolt sizes was compared with support loads. The support loads were derived using simplified techniques and standard support components and were based upon as-built conditions of typical small diameter piping systems. In all such cases, the calculated safety factors were well in excess of two with the exception of one support. However, there were a large number of supports having safety factors as high as 10 or greater. Additionally, the support loads obtained are conservative as compared to computer-analyzed piping support

loads. Previous comparisons between computer-analyzed piping and the simplified techniques indicate the results to be conservative by a factor of two or greater.

D. BASIS FOR PLANT OPERATION

The basis for plant operation for large piping as outlined above is also applicable to small piping. The data from the completed testing and inspection program are used to project trends for the remaining population of small pipe anchor bolts and base plates.

9. BLOCK WALLS

As indicated in CPCo's December 11, 1979, response to NRC IE Bulletin 79-02, Rev 2, the block wall separating the diesel generators was identified as not meeting the acceptance criteria for Seismic Category I loading conditions. This wall will be reinforced, and Category I piping supports attached to it will be relocated as appropriate prior to plant startup.

10. CONCLUSION

Based on considerations as outlined above, the intent of NRC IE Bulletin 79-02, Revisions 1 (Supplement 1) and 2 would be met for interim operation of the plant; i.e., a minimum safety factor of two will be maintained for all pipe support anchor bolts.