

Enclosure 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PACIFIC GAS AND ELECTRIC COMPANY

DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2

RESOLUTION OF ALLEGATIONS ON HITI ANCHOR BOLTS

DOCKET NOS. 50-275 AND 50-323

1.0 INTRODUCTION

Region V requested NRR assistance to resolve allegations on Hilti anchor bolts at Diablo Canyon Nuclear Power Plant, Units 1 and 2, on March 3, 1987. Telephone conferences had been held between the NRR staff and the allegor before the allegations were formally submitted to NRR, dated July 24, 1987.

The staff reviewed the allegations and found that they could be summarized as two technical issues. One is that the excessive embedment length of some bolts has been used, which had caused a cone shaped volume of concrete to pop out from the opposite side of a ceiling slab directly under the bolt. The other is whether the bolts from opposite sides of a slab have ever been designed and detailed for proper spacing.

With respect to the excessive embedment length issue, the specific bolts cited by the allegor were located in Area: GE, Elevation: 85, Column/Line: T & 12, Support 55S/41A, on Revision 4 of Drawing #049258, Line 1-K-106-18 C, Sys. #14. The allegor reported that a cone shaped section of concrete popped out of the ceiling directly under three of the Kwik bolts as they were being set or torqued. He also reported that these bolts were designed to have a minimum embedment length of 10½ inches in a 12 inch thick concrete floor. The allegor questioned the design adequacy of such a long embedment length of bolts, because the embedment length used has exceeded the one recommended by the manufacturer in its recently published Hilti Anchoring Manual.

With respect to the anchor spacing issue, it was reported that while drilling bolt holes for hanger 44-79R in the intake structure, the drill encountered the back end of an abandoned anchor bolt for hanger 44-78R. The allegor questioned whether the bolts on both sides of a floor slab had ever been designed for the two adjacent bolts located and pulled in the opposite directions, and detailed on the drawings for proper spacing. The allegor believed that the concrete between two adjacent bolts would be stressed less favorably when the bolts were located and pulled in the opposite directions of a floor than the case in which the bolts were located on and pulled from the same direction. The allegor questioned how the safe spacing between bolts was established by the licensee when the adjacent bolts were located and pulled in the opposite directions.

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The staff was convinced that the two technical issues can be resolved with review of pertinent information. Therefore, the staff requested the licensee to address the issues, and at the same time contacted the anchor bolt manufacturer, Hilti, for research information that may help to resolve the issues.

Responses submitted by the licensee and research information furnished by Hilti have contributed to the resolution of the issues. They will be discussed in the next section and the staff conclusion will be stated at the end.

2.0 EVALUATION

The licensee submitted its responses on the two technical issues on November 12, 1987. The licensee stated, in the submittal, that only anchor bolts that can be set to the required installation torque were used. In a submittal, dated June 1, 1984, related to the same issue, the licensee acknowledged that the concrete spalling did occur either during hammering the bolt into the hole or the torque-setting operation. In spite of the spalling the anchor bolts held the design torque of 360 ft-lb, and, therefore, were accepted, and the spalled areas were repaired. Furthermore, the licensee believes that the concrete that resists the pulling force from the steel anchor bolt is from the baseplate to the tip of the bolt, and is, therefore, unaffected by any concrete spalling on the surface opposite to the baseplate. The staff agrees with the licensee on this technical reasoning. The staff further agrees with the licensee's acceptance criterion for anchor bolts i.e, only anchor bolts that can be set to the required installation torque are used. Therefore, the use of some bolts with excessive embedment length, which has caused occasional concrete spalling on the opposite side of the slab directly under the bolt, may be undesirable with respect to appearance, but has no structural safety concern because the bolt could still hold 360 ft-lb torque as designed. Since the thickness of the spalled concrete in the direction of the depth of the slab is only one and one-half inches and the volume of the cone-shaped hole on the backside of the bolts is small, the strength of the slab containing a few such small holes is virtually unaffected. The licensee filled the holes with dry-pack grout, which is consistent with the industry practice.

In the November 12, 1987 submittal, the licensee stated that anchor bolt locations and types of anchors to be installed were shown on design drawings and the as-built drawings were reviewed and accepted by PG&E engineering, but no installation procedures were written for anchor locations on opposite sides of concrete structural elements. The licensee determined that the anchor bolt installation procedures did not need to address the spacing of adjacent bolts in the opposite directions for the following reasons: (1) Thin concrete slabs, concurrent with deep embedments from opposite sides, and near back-to-back anchor bolts is a rare configuration, (2) the simultaneous loading of adjacent bolts from opposite sides of a structural element to their maximum design load in tension is extremely unlikely, and (3) the allowable bolt loads used at Diablo Canyon plant are conservative. The staff believes that the stated reasons may be valid but are insufficient to conclude that all the anchor bolts at Diablo Canyon plant were installed properly.



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Test reports furnished by the Hilti bolt manufacturer have indicated that tests were made using two 3/4 inch x 10 inch bolts with 7 1/2" embedments installed from opposite sides of a 12 inch thick reinforced concrete wall with centerline-to-centerline spacings at 3, 2, and 1 1/2 anchor bolt diameters, respectively. Test results have indicated that there is no significant lowering of ultimate tensile load capability (less than 10%) of Hilti anchor bolts when the anchor spacing was reduced from 3 bolt diameters to 1 1/2 bolt diameters. A reduction in ultimate strength of 10% for expansion anchor bolts is insignificant because the ultimate strength is usually about 400% or 500% of the design. Based on the test results, the staff can conclude that those Hilti bolts at Diablo Canyon plant installed from opposite sides of a concrete structural element, spaced more than 1 1/2 times bolt diameters, centerline-to-centerline, can be considered as properly spaced. Since there is no test data for bolts installed from opposite sides of a wall, spaced less than 1 1/2 bolt diameters, available or known to the staff, it is not known whether there will be a sharp reduction in the bolt holding designed strength when the bolt spacing is less than 1 1/2 bolt diameters. The licensee has stated in the November 12, 1987 submittal that thin concrete slabs, concurrent with deep embedments from opposite sides, and near back-to-back anchor bolts is a rare configuration, and the majority of concrete slabs and walls in safety-related structures at Diablo Canyon are 24 inches thick or thicker, and the bolt embedment depths vary between 2 1/2 to 10 1/2 inches. However, this statement does not preclude the possibility of such a condition that bolts were installed from opposite side of a concrete structural element, spaced less than 1 1/2 bolt diameters. Therefore, the licensee is requested to either demonstrate that such condition is nonexistent or justify the use of the bolts with that condition.

The NRC IE information Notice No. 86-94 contains information that Hilti bolt manufacturer had downgraded bolt holding strength for some of its bolts, especially with long embedment length. The licensee is requested to review this information for applicability to Diablo Canyon plant and take appropriate actions to ensure bolt integrity.

3.0 CONCLUSION

The staff has reviewed the allegations, the responses submitted by the licensee, and research information furnished by Hilti bolt manufacturer. The staff has concluded, based on the above evaluation, that the allegations have been resolved except for one condition which needs to be confirmed, and one piece of information that needs to be reviewed, by the licensee. The condition to be confirmed is that there are no expansion anchor bolts installed from opposite side of a seismic Category I structural element with overlapping bolt length and spaced less than 1 1/2 times bolt diameter, centerline-to-centerline. If such a condition cannot be confirmed, the licensee is requested to justify the continued use of these bolts. The information that needs to be reviewed for its applicability is the NRC IE Information Notice No. 86-94. As needed, the licensee is requested to take actions to ensure bolt integrity.



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