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CENTRAL FILES

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September 17, 1979

Re: Indian Point Unit No. 2
Docket No. 50-247

Mr. Boyce H. Grier, Director
Region I
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pennsylvania 19406

Dear Mr. Grier:

By letter dated July 6, 1979 information as per the 120 day reporting requirements of IE Bulletin No. 79-02, and Revision No. 1 thereof, concerning pipe support base plate designs using concrete expansion anchor bolts associated with Seismic Category I piping systems at the Indian Point Unit No. 2 plant was forwarded to you. The July 6, 1979 letter discussed the Teledyne/Utility Group generic program and the Indian Point Unit No. 2 program, scope of work, current status and schedule.

The results of the Teledyne/Utility group generic program were presented at a meeting between the Commission, Teledyne and the Utility group members in Washington, D. C. on August 16, 1979. Teledyne Engineering Services sent copies of the final generic report No. TR-3501-1REV 1 entitled " Generic Response to US NRC IE Bulletin Number 79-02 - Base Plate/Concrete Expansion Anchor Bolts" to Mr. William Rutherford, US NRC on behalf of the Utility group members. A copy of the final generic report was also sent to Region I on September 7, 1979 on behalf of Con Edison. This report covers the development of shear-tension interaction curves and a computer code for analysis of bolt design load and deals with the cyclic load requirements and capability of expansion anchor bolts used at Indian Point Unit 2 plant.

The Indian Point Unit No. 2 plant has just completed a refueling/maintenance outage. The field verification program for the anchor bolts in support plates of Seismic Category I piping systems was performed by Ebasco during the refueling/ maintenance outage. The following paragraphs will discuss the analysis for the new bolt design loads, the description of the field verification program, modifications & repairs, QC documentation, inaccessible supports, field run piping and results and conclusions:

1. Analysis for New Bolt Design Load:
Analytical Model

Finite element analyses have been performed to compute the new bolt design loads per the requirements of the I&E Bulletin No. 79-02 Revision No. 1 and Supplement No. 1 thereof. The

analyses have been performed utilizing the pre and post processor programs developed by Teledyne Engineering Services for the computer code "ANSYS". The details of the analytical model, which includes the effect of prying action due to base plate flexibility, are contained in the report of Generic Program submitted to the Commission.

A parametric study was conducted to determine the sensitivity of bolt design load to the change in the tension and shear spring constants of the bolt. More than 90% of the anchor bolts used at Indian Point Unit 2 are of 3/4" or 7/8" size and the results of the parametric study indicate that the bolt loads of anchors of such sizes are not very sensitive to large changes in the spring constant. A comparison of the tension stiffness of the anchor bolts obtained from a program of proof testing for ultimate load of the expansion bolts in site concrete to actual spring constants used in the analysis confirmed that the calculated bolt design loads are conservative.

Computation of Factor of Safety

The factor of safety between the bolt design load and bolt ultimate capacity was determined using shear-tension interaction as follows:

$$\frac{\text{Actual Tension}}{\text{Allowable Tension}} + \frac{\text{Actual Shear}}{\text{Allowable Shear}} \leq 1.0$$

Actual tension and shear values are those computed by the computer program and allowable tension and shear values were taken as one fifth (shell type anchors) of ultimate values recommended by the manufacturer. The ultimate capacity of the bolts used in the above formulation has subsequently been confirmed to be conservative through a proof testing program at the site.

As a result of the above analyses, a total of 37 supports out of 1481 were identified which did not meet the requirements of a minimum factor of safety of 5. These supports have been modified to assure factors of safety greater than 5. The factor of safety distribution for the remaining 1444 supports is as follows:

Factor of Safety	Percentage Distribution
5 to 10	17.8%
10 to 20	15.1%
20 to 25	7.4%
Greater than 25	59.7%

The results of the analyses presented above indicate that the original design of Indian Point Unit 2 piping systems was very conservative. Also the factor of safety calculated above is based on a linear shear-tension interaction which has been proven to be overly conservative by tests conducted on shell type anchors by Teledyne Engineering Services for the Anchor Bolt Generic Program.

2. Field Verification Program:

An elaborate on-site program for complete visual inspection and tension testing of subject anchor bolts was started at the Indian Point Unit 2 plant on June 4, 1979 and was completed on September 13, 1979. Ebasco Procedure No. COED 2990-01, which described this program, was submitted to the Commission as an attachment to our July 6, 1979 letter. Some important elements of the field verification program are as follows:

Visual Inspection:

a. Verify that correct bolt and correct plate size were used. Verify plate geometry & edge distances.

b. Verify that expansion anchors were properly installed to correct depths.

c. Verify that adequate thread engagements exist.

d. Verify that there is no excessive angularity to the anchor, nut, or bolt.

Tension Tests:

a. Tension test each anchor to its maximum allowable load. If anchor did not pass visual inspection, tension test anchor to its maximum allowable load or 5X design load, whichever is higher. To validate tension test, check that the shell is not in contact with the back of the support plate prior to tension testing.

b. Verify that anchor is properly set.

c. Verify that there is no anchor slippage. Hold test load for minimum of 30 seconds after reaching maximum load. Check for any movement of anchor during tension test.

Proof Testing At Site:

A separate program was conducted where anchor sleeves were installed in a non-safety related area (i.e., concrete in yard area which is located east of the Turbine Building) and then pulled to failure. The proof testing program confirmed the anchor bolt ultimate load capacity and established installation torques.

3. Modifications & Repair:

As mentioned earlier, 37 supports out of 1481 were identified to have a factor of safety less than 5. The design of these supports has been modified to meet the minimum factor of safety requirements. Typical design modifications included addition of bracings, thickening of base plates and installation of additional anchors bolts. All field modification work has been completed.

Plates rejected due to either visual inspection failure or tension test failure were repaired and fully retested as per the procedure. "Hilti" wedge type anchor bolts were used for all modifications and repairs. The procedure for installation of wedge type anchor bolts was developed based on manufacturer's recommendations and installation torques were developed by actual field testing at the site by Hilti Fastening System Inc.

4. QC Documentation:

Test data sheets and QC documentation to verify the proper installation of expansion anchors covered by this program have been retained at the site for inspection. Ebasco's final report on the program entitled, " Consolidated Edison Company of New York Indian Point Nuclear Generating Facility Unit No. 2-Report on Concrete Expansion Anchor Verification Program" dated September 1979 is also available at the site for review.

5. Inaccessible Supports

Eighty-two (82) supports inside Containment on 33 lines and one hundred and eighty-nine (189) supports outside containment on 60 lines could not be tested because of high radiation or equipment obstructions. The minimum radiation level criteria for calling a support inaccessible due to high radiation was 200 MR/hr. However, in most cases, fields were much higher. For example, Support SR-616 on line 266 inside containment is located in an area where the field radiation was 1000 to 3,500 MR/hr. This was verified by a field radiation survey and the form was attached to the data sheet for that plate. Support plates were physically obstructed due to the presence of HVAC ducts, pipes or structural members that could not be removed and blocked the attachment of the tension testing equipment. For example, expansion anchor or Support ACH-461 on Line 247, was inaccessible due to location of a pipeline in front of the anchor bolt.

To provide as much documentation as possible on inaccessible supports, a remote visual inspection was performed, where possible. Approximately 95% of such supports inside containment and 50% of such supports outside containment received remote visual inspections. The remote visual inspection verified that the support plates were bolted to the concrete, that there were no missing or skewed bolts and that the complete support structure was in an acceptable condition.

Furthermore, stress analyses have been performed on these lines assuming that a support not tested due to high radiation or obstruction was non existent. The number of supports assumed to be non existent was based on a failure rate greater than those obtained from the field verification program and a "worst-case" configuration was considered in the stress analysis of each line. This assumption is very conservative as it implies that all the bolts in the support plate will fail during a postulated seismic event and the support will cease to provide even partial restraint. With these conservative assumptions, the maximum seismic stresses were calculated as per the criteria in the FSAR and added to the maximum dead weight and longitudinal pressure stress. The combined total stresses due to sustained loads have been compared with code allowable stress limits. The maximum combined stress has been found to be within the code allowable limits in all but one case which is well below the yield stress.

This single case, the component cooling water return from the reactor coolant pumps lube oil coolers (line #14), was further reviewed with regard to the bolt design load and found to carry a maximum bolt load of 500 lbs in shear. The factor of safety for this anchor bolt is 37, well above the minimum requirement. Also a remote visual examination has been completed on this plate which confirmed that the support is in good condition.

6. Field Run Piping Systems 2½" Diameter & Smaller

Field run piping systems 2½" in diameter and smaller were installed at Indian Point Unit No. 2 using conservative typical designs and standard span charts. Four representative lines inside containment, ranging from 3/4" to 2" in size, were selected for verifying the proper design and installation of supports. The lines were marked and located on the piping drawings and walked. All supports were labelled and marked. Two supports on each line were randomly selected for complete visual inspection and tension testing as per Ebasco's detailed procedure CO-ED-2990-01. All inspections completed on the support plates of field run lines passed the visual examination and tension test. The bolts were pull tested to the maximum allowable loads for the size of bolt installed.

Calculation of bolt loads on 1" diameter representative (typical) field run line has indicated a maximum bolt load of 100 lbs. (tension) which corresponds to a factor of safety of 50. The factor of safety for the worst "as-found" configuration on 1" field run line has been calculated to be 28. A similar calculation on a 2" diameter line indicates a factor of safety of 13 and 16 for a representative line and a worst "as-found" configuration respectively. The shear load on these lines was in the order of 10 to 20 lbs.

The design and installation of concrete expansion anchors on field run seismic category I piping systems 2½" diameter and smaller at Indian Point Unit No. 2 are, therefore, considered adequate due to the large safety margins.

7. Results & Conclusions:

As can be seen from the aforementioned data and our submittal dated July 6, 1979 on the same subject, a very thorough and complete analytical and field verification program has been completed at Indian Point Station Unit No. 2. The following summarizes the results & conclusions:

a. 100% of accessible supports inside containment and outside have been completely inspected & pull tested using sampling method "a" given in Appendix A of the IE Bulletin No. 79-02 (Revision No. 1).

b. All modifications and repairs necessary to ensure a minimum factor of safety of 5 have been completed and successfully retested.

c. QC documentation, test data sheets and detailed procedures for visual inspection, tension testing, remote visual examination of inaccessible supports, proof testing of anchor bolts in site concrete, and installation of new wedge type bolts are available at the site for inspection. Ebasco's final report on the program is also available at the site for review.

d. A failure rate of 8.2% has been determined for supports tested inside containment. The failure rate for supports outside Containment is 8.0%. The overall failure rate is approximately 8.1%.

e. 271 inaccessible supports, 82 inside Containment and 189 outside, out of a total of 1481 have not been tested. However, a remote visual examination of approximately 95% of such supports inside containment and 50% of such supports outside containment has confirmed that they appear in good condition. Also the stress analysis discussed in Section 5 of this letter which assumed a higher suppport failure rate than obtained from the field verification program indicates that the operability of the piping systems will not be affected in the absence of these supports.

Based on a failure rate of 8.1% on the large sample of supports tested (1210 tested out of a total of 1481), the statistical range of defective supports remaining on the system is bounded by 4.4% to 11.6% defective for a confidence level of 95% or between 3.7% to 12.4% for a confidence level of 99%. Using the upper limit of 99% confidence level, no more than 33 (.1233 x 271) supports of the 271 inaccessible supports could be defective. In other words, based on the data presented above, it can be stated with a 99% confidence that no more than 2.2% of the seismic category I pipe supports using concrete expansion anchor bolts at Indian Point Unit 2 are defective. Considered on the basis of operability of piping systems & including all supports i.e. supports other than those with expansion anchor bolts, the number of potentially defective supports at 99% confidence level will be even less than 2.2%.

It is, therefore, concluded that Seismic Category I piping systems at Indian Point Unit 2 will remain functional in the event of a safe shutdown earthquake and the plant will remain operable and pose no potential hazard to the health & safety of the public.

This concludes our verification program of concrete expansion anchor bolt & base plate design for Indian Point Unit 2 Seismic Category I piping systems and completes our response to IE Bulletin No. 79-02 Revision 1 & Supplement thereof.

Should you or your staff have any questions, we would be pleased to discuss this with you.

Very truly yours,

William J. Cahill, Jr.

William J. Cahill, Jr.
Vice President

cc: U. S. Nuclear Regulatory Commission
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