



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

COMMONWEALTH EDISON COMPANY

DRESDEN UNITS 2 & 3 AND QUAD CITIES UNITS 1 & 2

DOCKET NOS. 50-237/249 AND 50-254/265

FLUED HEAD ANCHOR ASSESSMENT PROGRAM

INTRODUCTION

In September of 1987, concerns were raised regarding structural integrity of the flued head anchors (FHA) at Dresden Units 2 and 3 and Quad Cities Units 1 and 2. It was found that pipe supports in the containment penetration area which utilize FHA were not included under the IEB 79-14 scope of work. Consequently, the as-built configuration of these anchor structures was never verified. The staff held a meeting with Commonwealth Edison Company (CECo), the licensee, at the NRC headquarters on September 14, 1987 in which CECo presented the original design basis loads and analytical methodologies for the FHA structures in question. Based on the presentation, the staff immediately informed CECo that (1) the presentation did not appear to be sufficient for staff acceptance, (2) the FSAR commitment on rupture load criteria needs to be further reviewed, (3) design loading combinations consisting of seismic load and rupture load need to be reassessed, and (4) a staff audit will be needed on the adequacy of FHA calculations, including analytical modelling, design stress criteria, and as-built configuration.

On January 26-28, 1988, the staff and the consultants from Brookhaven National Laboratory (BNL) conducted an audit on CECo's FHA design calculations at the corporate's headquarters of Sargent & Lundy (S&L) and Impell Corporation, both of CECo's consultants, in Chicago. The audit team identified to CECo several deficiencies in the FHA design calculations which were later included in the Region III Inspection Report No. 50-254/87028 (DRS) and 50-265/87028 (DRS). The audit team suggested that CECo initiate a comprehensive FHA program to correct the deficiencies identified. Specially, it was recommended that the program should include the following as a minimum:

- (1) Document all as-built penetration support configurations including anchor bolts.
- (2) Verify and demonstrate reliability of the original calculations. If necessary, revise pertinent parts of the calculations.

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- (3) Verify conformity of the as-built configurations with the design drawings. If required, perform new calculations to address deficiencies.

Since then, CECO has substantially enhanced the program with updated design calculations. In the process, close communications were maintained between the audit team and CECO in relation to the status of the program development as well as resolution of some previously identified technical deficiencies. On January 24 and 25, 1989, the staff and the BNL consultants conducted a follow-up audit at S&L's headquarters in Chicago to assess the completeness of the FHA program and to review the new design calculations and documents prepared by S&L.

EVALUATION

The as-built FHA configurations were inspected in the field by the Region III staff as detailed in the above inspection report. Out of a total of 58 FHAs for the four units, 45 FHAs were observed to have configuration deviations compared to the original design. All the anchors were then reanalyzed by CECO and, when found necessary, members were added. A total of 34 FHA frames required modifications. These structural modifications had been implemented in the field for Dresden Units 2 and 3 and Quad Cities Unit 2. According to CECO, the field work for Quad Cities Unit 1 will be completed at the next refueling outage which is scheduled for the latter part of 1989.

The audit team reviewed the FHA structure analysis and design calculations performed by S&L for selected FHAs. The selection was based on representative samples of different combinations of configuration deviations and the resulting modifications for the four units. Specifically, calculations for the following FHAs were reviewed:

Dresden Unit 2 - X-109B, X-111B, X-144, X-130
Dresden Unit 3 - X-108A, X-128
Quad Cities Unit 1 - X-13A, X-16B
Quad Cities Unit 2 - X-16B, X-36

The following generic observations were made for these calculations:

- Mathematical modelling and computer analyses were performed based on the as-built configurations.
- Appropriate modifications were made and the analyses were repeated on the modified structures, when the as-built configurations were found inadequate to carry the design loads.
- Bracing connections were assumed pinned.
- Joints of other frame members were assumed fixed.
- The support connections were assumed pinned or fixed or elastic depending on the degree of fixity suggested by the moment-rotation (M-0) curves obtained for the connections.

- ° In general, the shear lugs were assumed to carry the shear loads and the anchor bolts to carry the tensile loads. However, some anchor bolts were assumed to carry both shear and tension, for cases where shear lugs were absent.

The audit team noticed a substantial improvement made in the FHA program since the previous audit. The program appears to be strengthened by the involvement of knowledgeable technical personnels as well as sound QA/QC procedures. Majority of the remaining program deficiencies as identified during the previous audit were resolved to the team's satisfaction. The following comments by the team, however, remained to be resolved at the end of the audit:

- (1) A complete list of configuration deviations and modifications needed to be provided.
- (2) On the final design drawings of anchor structures, some sketches do not reflect as-built configurations. For example, all the revisions made in the frame details are not incorporated in the overall anchor structures drawings. It is required that the final drawings be verified for consistency.
- (3) Certain structural elements (e.g. stiffening or gusset plates) called for in the original design drawings were missing in the field. Although proved to be inconsequential, such apparent omission should be investigated for any specific need of these components in the original design. Also incorporate the investigation effort and results in the revised design documentations.
- (4) Some rock anchors and thru bolts were assumed to carry both shear and tension loads. However, the acceptance criteria provided to the audit team do not address such a combination for the anchor bolts. The criteria should be revised to include the interaction effect between shear and tension loads.

Subsequent to the above meeting at S&L, CECO has responded to the above comments in its letters of January 31, February 21, and March 15, 1989. The additional efforts included in the responses were found to have satisfactorily resolved all the concerns identified above by the audit team.

CONCLUSION

Based on the recent audit of the CECO's FHA program and S&L's latest design documentations, as well as the review of the follow-up responses provided by CECO after the audit, the staff concludes that the CECO's FHA program has been adequately defined and is being properly implemented. For completion of the entire scope of the program, however, the field modifications of FHAs for Quad Cities Unit 1 should be completed at the next refueling outage. At that time the entire FHA portion of the IEB 79-14 program will be considered completed.

Principle Reviewer: Arnold Lee

Dated: May 15, 1989