UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SUPPLEMENTAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE PROPOSED REPAIR FOR THE CORE SHROUD

COMMONWEALTH EDISON COMPANY

AND

IOWA-ILLINOIS GAS AND ELECTRIC COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NUMBERS 50-254 and 265

1.0 BACKGROUND

In June 1995, Commonwealth Edison Company (ComEd) completed the core shroud repair installation at Quad Cities, Unit 2. The core shroud repair was designed as an alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) pursuant to Title 10 of the Code of Federal Regulations, Part 50.55a(a)(3)(i). The installation had been evaluated and found acceptable by the staff (Reference 1). In teleconferences dated June 14 and June 16, 1995, ComEd informed the staff of an event which caused inadvertent loading on the core shroud repair hardware at Quad Cities Nuclear Station, Unit 2. During reassembly of the reactor vessel internals, ComEd discovered that the core shroud head/moisture separator support legs directly impinged on the heads of tie-rod stabilizer assembly long upper supports (LUS) at two locations. ComEd halted the reactor reassembly effort and performed an evaluation of the event. In Reference 2 ComEd submitted a 10 CFR 50.59 safety evaluation for the Quad Cities, Unit 2, core shroud repair hardware. In Reference 3, ComEd submitted a revision of Reference 2 which addressed the effects of this inadvertent loading on the core shroud repair hardware. Reference 1 contained three items that require correction. These items are evaluated in this safety evaluation.

2.0 EVALUATION

2.1 Structural Evaluation

ComEd performed a remote visual inspection of the core shroud repair hardware using underwater cameras. Based on the results of this inspection, ComEd concluded that the affected core shroud repair hardware was intact and did not sustain any visible deformation or damage.

In Reference 3 ComEd reported the results of stress analyses to support the conclusion of the visual inspection, in which "at rest" and "impact" conditions were analyzed and evaluated. The analysis of the "at rest"

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condition assumed that the weight of the core shroud head/separator rested on two LUSs located on diametrically opposite azimuths on the core shroud. The analysis of the "impact" condition initially assumed that the entire core shroud head/separator impacted one LUS. Both analyses were based on the "dry weight" of the shroud head. The impact analysis also included an amplification factor to account for the impact of the core shroud head leg on the LUS. The highest bending and shear stresses were assumed to occur at the throat of the LUS head. Since the LUS is not fabricated from an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) material, ComEd adopted the ASME Code, Section III, methodology for determining the allowable membrane and bending stresses, corresponding to Subsection NB-3227.2, 1989 Edition, Service Level A Code allowable stresses. The allowable stresses for the LUS were based on the Sm value of the material (X-750) at operating temperature. ComEd also used the ASME Code, Section III, Subsection NG-3227.1, 1989 Edition to show the structural adequacy of the core shroud under this event. On this basis, ComEd determined that the stresses in the LUS did not exceed the allowable stresses in tension and shear, and that the allowable bearing stress in the core shroud flange was not exceeded.

The staff reviewed these analyses and concluded that they did not properly represent the deformation of the LUS when subjected to the core shroud head load, and that the stresses in the LUS were underestimated, as a result of using a simplified model. This conclusion was partially based on considerations reported in Reference 4. However, the staff also recognized that some of the assumptions on which the analyses were based were overly conservative. The staff, therefore, requested that ComEd provide the results of the analyses based on more realistic assumptions and a refined model of the LUS.

In Reference 5 ComEd provided additional calculations of the stresses in the critical region of the LUS, based on more realistic loading conditions and a three-dimensional solid finite element analysis (FEA) model of a LUS, which was used previously for the analysis of LUS under normal and accident conditions. This model was previously evaluated by the staff in Reference 1. The load on a LUS was taken as half the buoyant weight of the core shroud head and the dynamic amplification factor was reduced from 1.25 to 1.15. The impact condition, thus, became the governing loading condition. The allowable stresses were determined at room temperature, instead of at operating temperature (550 degrees), since the inadvertent loading condition occurred at room temperature. The allowable stresses were based on the ASME Code, Section III, Subsection NG, allowable limits as shown in Figure NG-3221-1. The staff found these changes acceptable. However, the staff also found that the model did not reflect the precise boundary conditions and the actual impact load acting on the LUS and, therefore, an additional analysis was requested. In Reference 6 ComEd provided revised results based on the FEA model of the LUS in Reference 5, and demonstrated that the stresses in the LUS meet the specified allowables. The staff finds these results acceptable. Therefore, based on ComEd's report of the visual inspection and the staff's evaluation of the ComEd documentation, the staff finds ComEd's actions to be acceptable.

2.2 ComEd's 10 CFR 50.59 SE of the Core Shroud Repair

In Reference 3, ComEd submitted a revision of Reference 2 which addressed the effects of this inadvertent loading on the core shroud repair hardware. In accordance with 10 CFR 50.59, ComEd determined that no unreviewed safety question has been introduced and no Technical Specification revision is involved as a result of the inadvertent loading on the core shroud repair. The staff agrees with this determination, and concludes that no license amendment, pursuant to 10 CFR 50.90, is necessary.

2.3 Corrections to the NRC's Original June 8, 1995, Safety Evaluation

There are three areas in the original June 8, 1995 Safety Evaluation (SE) that need to be revised. The changes and evaluation follow.

2.3.a Vertical Weld Indications

The third sentence in the first paragraph of Section 2.1 reads as follows: "As stated in Section 2.5.2, ComEd also inspected the vertical welds and determined that cracking in these welds has been limited to relatively small lengths (less than 3 inches with one exception, where a 15 inch crack was observed)." ComEd had actually reported no indications in their submittal dated June 2, 1995. This sentence should read: "As stated in Reference 28, ComEd also inspected the vertical welds and determined that there were no reportable indications. Industry experience of cracking in these welds has been limited to relatively small lengths (less than 3 inches with one exception where a 15 inch crack was observed)."

2.3.b Vertical Separation of Welds

In the second full paragraph, the fourth sentence on page 4 reads as follows: "Vertical separation for any and all welds is precluded except for the postulated design event consisting of a main steam line break loss of coolant accident combined with a design basis earthquake, since excessive preload would be required to prevent any separation for this event." As stated in Section 2.4.6 of the original SE a postulated vertical separation could occur during a main steam line break (MSLB) or design basis earthquake (DBE) or a combination of a DBE and MSLB. This sentence should read: "Vertical separation for any and all welds is precluded except for the postulated design events addressed in Section 2.4.6 of this SE."

2.3.c Circumferential Indications

In the first full paragraph on page 18, Section 2.5.2, the first sentence reads: "ComEd reported ... (b) eight (8) circumferential indications ... of the horizontal weld H5." ComEd reported in a letter dated June 2, 1995, that there were six (6) circumferential indications. Therefore, the sentence should read: "ComEd reported ... (b) six (6) circumferential indications ... of the horizontal weld H5."

3.0 CONCLUSION

The staff has reviewed the supporting documentation provided by ComEd, and has concluded that ComEd has demonstrated that the stresses in the core shroud repair hardware, resulting from the reported inadvertent loading condition, meet the specified allowable stresses. Based on the foregoing discussion, the staff, therefore, concludes that the safety of the proposed core shroud repair modification was not compromised by the inadvertent loading condition, and that the event did not impact the ability of the core shroud repair hardware to perform its intended safety function.

The corrections made to the original June 8, 1995, SE are administrative in nature and do not affect the conclusions of that SE.

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Date: September 11, 1995

REFERENCES

1. Letter from R. M. Pulsifer, NRC, to D. L. Farrar, ComEd, with enclosed Safety Evaluation, dated June 8, 1995.

2. 10 CFR 50.59 Safety Evaluation NEP 04-03, Attachment B, Revision 1, Quad Cities Station Units 1 & 2, Mod M04-1(2)-94-007, March 20, 1995.

3. Letter from J. L. Schrage, ComEd, to the USNRC, Document Control Desk, with attachment "Revised 10 CFR 50.59 Safety Evaluation - Core Shroud Repair, Revision 4, June 16, 1995," dated June 19, 1995.

4. Roark, R. J., and Young, W. C., "Formulas for Stress and Strain," 5th Edition, 1975, p. 186.

5. Letter from J. L. Schrage, ComEd, to the USNRC, Document Control Desk, dated June 30, 1995.

6. Letter from J. L. Schrage, ComEd, to the USNRC, Document Control Desk, dated July 6, 1995.