



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

50-254/263

September 22, 1998

Mr. Oliver D. Kingsley, President  
Nuclear Generation Group  
Commonwealth Edison Company  
Executive Towers West III  
1400 Opus Place, Suite 500  
Downers Grove, IL 60515

SUBJECT: REVIEW OF QUAD CITIES 10 CFR 50.59 EVALUATION AND SUPPORTING DOCUMENTATION INCLUDING GL 97-04 RESPONSE RELATING TO ADEQUATE NPSH FOR ECCS PUMPS AND USE OF CONTAINMENT OVERPRESSURE (TAC NOS. MA0034 AND MA0035)

Dear Mr. Kingsley:

By letter dated January 5, 1998, Commonwealth Edison Company (ComEd) responded to Generic Letter (GL) 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps." By letter dated May 12, 1998, ComEd also responded to questions raised during the NRC Design Inspection (Report Nos. 50-254/98-201 and 50-265/98-201) on containment overpressure. The questions raised were related to the amount of containment overpressure (COP) that is currently being used in the design bases net positive suction head (NPSH) calculations and whether it is consistent with the Quad Cities licensing basis. The staff also held a meeting with ComEd on June 19, 1998, concerning NPSH and COP issues at Quad Cities. It is ComEd's conclusion that the current Quad Cities NPSH design basis is in agreement with the original questions and responses raised during the licensing of Quad Cities, Units 1 and 2, the original NRC Safety Evaluation Report (SER) and all subsequent SERs, and the Updated Final Safety Analysis Report (UFSAR). In the judgement of ComEd, no unreviewed safety question (USQ) exists.

ComEd stated in its May 12, 1998, letter, "After receipt of the original design calculations and the reconstituted thermal analysis, our calculations and UFSAR will be updated and the 10 CFR 50.59 Safety Evaluation will be completed. This work will be completed by September 30, 1998. If a USQ is identified we will notify the NRC and a request for a license amendment will be submitted within 60 days of that date." At the June 19, 1998, meeting ComEd also said that, along with the analysis, it will provide the applicability study for using Dresden Station analysis for Quad Cities and the GE SHEX code bench marking used in the Quad Cities analysis.

The NRC staff has reviewed ComEd's January 5 and May 12, 1998, letters and supporting documentation. Based on our review, the staff does not agree with ComEd's conclusions that Quad Cities remains within its licensing basis and that no USQ exists with regards to the current use of COP. Our assessment is enclosed.

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O. Kingsley

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September 22, 1998

ComEd should submit the above-referenced committed information as stated above by September 30, 1998, and respond to the enclosed assessment within 30 days of receipt of this letter. If a USQ is determined to exist, ComEd should inform the staff in writing, commensurate with the safety significance, its schedule and plans for resolution of the issue.

Sincerely,

ORIG. SIGNED BY

Robert M. Pulsifer, Project Manager  
Project Directorate III-2  
Division of Reactor Projects - III/IV  
Office of Nuclear Reactor Regulation

Docket Nos. 50-254, 50-265

Enclosure: Assessment

cc w/encl: See next page

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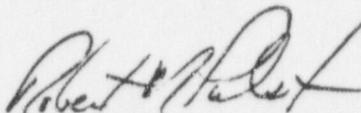
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O. Kingsley

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Sincerely,



Robert M. Pulsifer, Project Manager  
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ASSESSMENT OF QUAD CITIES 10 CFR 50.59 AND  
CONTAINMENT OVERPRESSURE

1.0 BACKGROUND

By letter dated May 12, 1998 (Reference 1), Commonwealth Edison Company (ComEd, the licensee) responded to questions raised during the NRC Design Inspection (Report Nos. 50-254/98-201 and 50-265/98-201) (Reference 2) on containment overpressure. The questions raised were related to the amount of containment overpressure that is currently being used in the design bases net positive suction head (NPSH) calculations and whether it is consistent with the Quad Cities licensing basis. The licensee concluded that the current Quad Cities NPSH design basis still agrees with the original questions and responses raised during the licensing of Quad Cities, Units 1 and 2, the original NRC Safety Evaluation Report (SER) and all subsequent SERs, and the Updated Final Safety Analysis Report (UFSAR), and in its judgement, no unreviewed safety question (USQ) exists.

The ComEd response to Generic Letter (GL) 97-04 (Reference 3), which the staff views as the current NPSH analyses for Quad Cities, states that the Quad Cities Station currently uses the following containment overpressure values to ensure adequate NPSH for the emergency core cooling system (ECCS) pumps.

Short term (0 to 600 seconds post-LOCA [loss-of-coolant accident])

RHR [residual heat removal]	6.2 psig
CS [core spray]	7.3 psig

Long term (greater than 600 seconds post-LOCA)

RHR	2.3 psig
CS	0.0 psig

The staff understands that ComEd believes that the current design-basis NPSH calculations for Quad Cities, Units 1 and 2, are based on the following documents:

The original staff SER dated August 25, 1971 (Reference 4), which stated that "a few psi" of containment overpressure was needed to meet the RHR pump NPSH requirements.

The January 4, 1977, staff SE (Reference 5) for Dresden and Quad Cities which concluded that low-pressure coolant injection (LPCI) pump damage due to cavitation would not occur during the short term (first 10 minutes post-LOCA) based on the analyses and test data that ComEd provided.

Until General Electric (GE) completes the Quad Cities containment analysis, Dresden's short-term minimum containment analysis is assumed to be applicable to Quad Cities. This includes the credited containment overpressure approved for use at Dresden Station.

The 1993 GE containment overpressure analysis for Quad Cities and assumptions/methodology used for the Dresden licensing amendment. The staff has not received or reviewed this document.

ENCLOSURE

## 2.0 DISCUSSION

In the original U. S. Atomic Energy Commission (AEC) SEF, dated August 25, 1971, the staff made the following conclusion with regards to adequate NPSH for the ECCS pumps:

Our review of the RHR system LPCI mode and the core spray emergency cooling mode indicates that a containment overpressure of a few psi is needed for about 8 hours following a design basis LOCA to assure adequate NPSH to the RHR pump in the LPCI mode. For an initial suppression pool water temperature of 95 degrees F, the calculated time for which containment overpressure may be required is based also on using the minimum heat removal capacity of the RHR system, one RHR heat exchanger, one RHR pump, one RHR service water pump with a maximum suppression pool temperature of 170 degrees F. We conclude that the reliance placed on a small containment overpressure for the Quad Cities Units 1 and 2 using the minimum heat removal capacity of the RHR system will not adversely affect the performance of the ECCS.

Adequate NPSH to the RHR and core spray pumps was not evaluated during the short term, first 600 seconds, post-LOCA. The staff found the use of a small amount of containment overpressure for the RHR pumps during the long-term post-LOCA, greater than  $10^3$  seconds, acceptable after considering the following information provided by the licensee:

FSAR Amendment 13 (Reference 6) Question 6.2 response provides Figure 6.2-1 which shows the containment pressure required and containment pressure available for adequate NPSH at the LPCI and core spray pumps following a design basis LOCA. Figure 6.2-1 begins at  $t = 10^3$  seconds and containment overpressure required appears to be around 1 psig for the RHR pumps. Containment overpressure is not required for the core spray pumps.

FSAR Amendment 16 (Reference 7) Question 6.1 dated February 8, 1971, provided a discussion of the differences between Quad Cities and Dresden 2. "For the same assumptions, with regard to equipment operating (1 RHR pump, 1 SW pump, 1 heat exchanger[,]) initial pool temperature and service water temperatures), the Quad Cities NPSH results will be identical to Dresden [2]. The figure in D 2/3 amendments 9 and 10 represents the condition for 1 RHR heat exchanger with 2 service water pumps and 1 RHR pump operating which is a possible loading for a one (sic) diesel on Dresden. On Quad Cities the SW pumps have larger motors and only one can be operated on one diesel in combination with other emergency loads. Thus, the pool temperature transient is slightly different for Quad Cities and Dresden."

FSAR Amendment 17 (Reference 8) dated March 1, 1971, provided an updated Figure 6.1-1 and described the RHR heat exchanger duty. Both Dresden and Quad Cities were designed for a RHR heat exchanger duty of 105 million BTU/hr. The degraded case shown in the Quad Cities Figure 6.1-1 has an RHR heat exchanger duty of 66 million BTU/hr assuming a cooling water temperature of 95 [degrees Fahrenheit] °F and a torus water temperature of 165°F.

In the NRC SE dated January 4, 1977, the staff evaluated the GE SIL 151 condition that postulates a LPCI loop select failure following a LOCA. This condition would result in LPCI runout flows and LPCI pump cavitation during the short term of the accident. This was the first time that adequate NPSH to the RHR pumps for the short term was evaluated by the staff. The staff concluded for both Dresden and Quad Cities that LPCI pump damage due to pump runout and cavitation would not occur during the short term. The staff found the analyses acceptable after considering the assumptions used in the analyses. These assumptions were provided in a letter dated August 2, 1976 (Reference 9).

1) Torus water temperature is 130°F and is assumed to be the maximum to which the torus water temperature will increase, 2) no credit is taken for increase in torus level after the LOCA, 3) atmospheric pressure about [above] the suppression pool and in the drywell is 14.7 psia, 4) reactor pressure is 56 psig, 5) the containment cooling heat exchanger bypass valve is open, 6) LPCI and RHR design flow point is 5350 gpm, 7) run out is interpreted as a point on the flow characteristic at which cavitation occurs because the net positive suction required exceeds the available NPSH, and 8) the suction valve will isolate even if the discharge valve does not and thus prevent backflow through the pump.

Based on these assumptions, the worst case of all four plants was a 3-foot NPSH deficit (1.28 psig) at a suppression pool temperature of 130°F for the Dresden Case 2 three LPCI pump combination and a 2-foot deficit (0.85 psig) at a suppression pool temperature of 130°F for the Quad Cities Case 1 three LPCI pump combination. Short-term LPCI pump cavitation was accepted by the staff based upon pump testing performed by the licensee that showed that pump damage would not result from the potential cavitation. The use of containment overpressure to prevent LPCI pump cavitation was not evaluated in the staff 1977 SE. Adequate NPSH for the core spray pumps was not evaluated for any of the units.

Since the issuance of the original licensing SER and the 1977 staff SE, errors have been identified in the original NPSH calculations and changes have been made to both the calculations and methodology. In December 1996, the licensee discovered documents that stated that the actual head loss across the ECCS strainers was 5.8 feet at 10,000 gpm versus 1 foot at 10,000 gpm as designed. The licensee evaluations performed to support ECCS operability were based on the following assumptions: (1) initial torus temperature at time zero = 95°F, (2) suction strainer loss = 5.8 ft at 10,000 gpm, (3) short-term pumps - all LPCI and core spray pumps running unthrottled, (4) long-term pumps - all LPCI and core spray pumps throttled to design value, (5) containment overpressure required - per 1993 GE evaluation - short term 5.5 psig, long term 3.4 psig, (6) torus temperature - per 1993 GE evaluation - short term 150°F, long term 180°F, (7) one strainer plugged and 3 strainers clean, (8) Quad Cities runout flow per similarity with Dresden 1996 calculations, (9) torus water at minimum elevation including drawdown, and (10) suction losses - per new 1996 Flo-series computer model that calculates the piping losses.

On January 22, 1997, Quad Cities issued LER 96-025 (Reference 10) which reported the increased head loss of the ECCS strainers. The LER stated that the operability determination concluded that the ECCS pumps were "operable, but degraded" and that no emergency notification system (ENS) call was required. The LER concluded that the 1993 GE analysis "results in the minimum containment overpressure being slightly higher in the long term than the value shown in UFSAR Figure 6.3-42. The short-term overpressure analysis also employed a

methodology that conservatively minimized (lowered) the calculated containment overpressure available. This analysis was performed in November 1996 for the Dresden Station. An evaluation of the Dresden and Quad Cities parameters used as inputs verified that the Dresden analysis could be conservatively used for Quad Cities." Additionally, the LER noted that "during preparation of the safety evaluation it was also determined that the original containment overpressure information in the UFSAR could be revised to include the 1993 analysis. This is based on the original NRC safety evaluation report (SER) which accepted use of containment overpressure, dated 082571. Review of the Quad Cities submittal to the NRC and their SER dated 010477, reviewed (sic) the conditions of run out pump cavitation, was included in the 10CFR50.59 safety evaluation. It determined that no unreviewed safety question exists. Therefore, based on the UFSAR change the ECCS pumps are operable, and no longer considered degraded."

Some of the differences in assumptions between the 1977 NRC SE and the 1996 Quad Cities operability evaluation include the increased strainer head loss, the increase in the containment overpressure required for short term (0 psig to 5.5 psig), the increase in the containment overpressure required for long term (~ 1 psig to 3.4 psig), increased suppression pool temperature at 10 minutes (130°F to 150°F), increased peak suppression pool temperature (170°F to 180°F), the 1993 GE containment analysis for Quad Cities, and the new suction losses per the 1996 Flo-series model. However, ComEd concluded that the increased strainer head loss did not create a USQ.

The ComEd 10 CFR 50.59 SE (Reference 11), which addressed the history of the installed suction strainers head loss values and the adequacy of the strainers to provide the required flow to the ECCS, was completed on January 10, 1997. The 10 CFR 50.59 evaluation resulted in changes to sections of the UFSAR and Technical Specification (TS) Bases. The last sentence of the following paragraph was removed from the bases of TS 3/4.7.K, Suppression Chamber, which discussed the NPSH available during the short-term post-LOCA:

Under full power operating conditions, blowdown from an initial suppression chamber water temperature of 95°F results in a water temperature of approximately 145°F immediately following blowdown which is low enough to provide complete condensation via T-quencher devices. At this temperature and atmospheric pressure, the available and required (sic) net positive suction head exceeds that required by the emergency core cooling system pumps, thus there is no dependency on containment overpressure during the accident injection phase.

In addition, changes were made to UFSAR Section 6.3.3.2.9, Net Positive Suction Head Availability, Table 6.3-18, *RHR Heat Exchanger Duty Variance with Flow*, and Figures 6.3-41, Containment Pressure Required and Containment Pressure Available for Adequate NPSH at the LPCI and Core Spray Pumps Following a Design Basis LOCA With an Initial Pool Temperature of 90°F, and 6.3-42, *Containment Pressure Required and Containment Pressure Available for Adequate NPSH at the LPCI and Core Spray Pumps Following a Design Basis LOCA With an Initial Pool Temperature of 95°F* to make them "reference only." These revisions to the UFSAR were included for historical purposes since the calculations for these curves were "not available."

However, the staff notes that Figure 6.3-42 is quoted as the basis for the change to the TS bases discussed above and that Table 6.3-18 and Figures 6.3-41 and 6.3-42 are extremely similar to the table and figures provided in FSAR Amendment 17 dated March 1, 1971, which supported the Quad Cities licensing basis.

On April 30, 1997, Dresden received a license amendment that approved the use of a specified amount of containment overpressure. Based on this approval, ComEd stated in its May 12, 1998, letter that "the current Quad Cities NPSH calculations are based on a Quad Cities hydraulic piping model, the short-term 1997 Dresden [containment overpressure] COP analysis, the 1993 Quad Cities COP analysis and assumptions/methodology used for the Dresden licensing amendment. The Dresden COP containment analysis is applicable to Quad Cities based on the similarity between the stations. The credited COP was approved for Dresden Units 2 and 3 via Amendments 157 and 152."

According to the GL 97-04 response, these values are from calculations QDC-1000-M-0454, Revision 0, and QDC-1000-M-0535, Revision 0, which credited the containment overpressure approved for use at Dresden. The May 12, 1998, letter stated that "the required COP in the short term as stated in the GL 97-04 response is based on the pressure required to prevent cavitation at 240 seconds and conservatively using the peak pool temperature at 10 minutes. However, since short-term pump cavitation is acceptable, the RHR pumps do not require any COP in order to provide the required flow and the core spray pumps require less than 3 psig at the concurrent pool temperature (i.e., an overpressure of a few psi as stated in the SER) to maintain required flow to the core to ensure that the postulated peak cladding temperature is not affected. Therefore, the current NPSH design bases including the required COP is in agreement with the 1971 and 1977 SERs." The May 12, 1998, letter appears to be inconsistent with the GL 97-04 response.

The staff has reviewed the ComEd letter and supporting documentation. Based on this review, the staff has concluded that Quad Cities is outside its licensing basis with respect to the amount of containment overpressure credited for the short- and long-term analyses of adequate NPSH. Specifically, the staff believes that when Quad Cities Station was licensed, it was credited with a small amount of containment overpressure for the RHR pumps during the long-term post-LOCA. The use of containment overpressure for the short-term NPSH analyses for the RHR and core spray pumps at Quad Cities has not been reviewed and approved by the staff.

The staff defines "increased reliance on containment overpressure" as an increase in the absolute amount of containment overpressure required to ensure adequate NPSH. The staff also believes that Quad Cities has increased the time that containment overpressure is required. Additionally, the staff believes that the plant design assumptions evaluated in the original AEC SER (August 25, 1971) and the staff's 1977 SE (January 4, 1977) do not reflect the current design assumptions of the plant due to the use of new calculations and methodologies.

### 3.0 CONCLUSION

The staff has reviewed the ComEd letter and supporting documentation. The staff does not agree with ComEd's conclusions that Quad Cities remains within its licensing basis and that no USQ exists with regard to the current use of containment overpressure. The staff concludes

that Quad Cities Station was licensed with a small amount of containment overpressure credit for the RHR pumps during the long-term post-LOCA. The use of containment overpressure for the short-term NPSH analyses for the RHR and core spray pumps at Quad Cities has not been reviewed and approved by the staff. The staff concludes that the plant design assumptions evaluated in the original AEC SER (August 25, 1971) and the staff's 1977 SE (January 4, 1977) do not reflect the current design assumptions of the plant due to the use of new calculations and methodologies. The staff also concludes that the licensee's reliance on containment overpressure to ensure adequate NPSH for the ECCS pumps has increased in both amount and time the containment overpressure is required. These conclusions are based on the staff's review of the licensing history of Quad Cities and the Quad Cities 10 CFR 50.59 dated January 10, 1997.

In accordance with 10 CFR Part 50, Appendix B, Criterion XVI, if it is found that a USQ exists the staff expects that ComEd will take prompt corrective action to restore the facility to a condition consistent with the licensing-basis until such time as an acceptable licensing basis change is approved by the staff.

Principal Contributor: K. Kavanagh

Date: September 22, 1998

#### 4.0 REFERENCES

1. Dimmette, J.P. Jr., ComEd, to USNRC, "Quad Cities Nuclear Power Station Units 1 and 2, Response to Questions Raised During NRC Design Inspection on Containment Overpressure," Docket Nos. 50-254/50-265, May 12, 1998.
2. USNRC Inspection Report, "Quad Cities Nuclear Power Station, Design Inspection (NRC Inspection Report Nos. 50-254/98-201 and 50-265/98-201)," May 6, 1998.
3. Hosmer, J., ComEd, to USNRC, "90 Day Response to Generic Letter 97-04 - Braidwood Nuclear Power Station, Units 1 and 2, Byron Nuclear Power Station, Units 1 and 2, Dresden Nuclear Power Station, Units 2 and 3, LaSalle County Nuclear Power Station, Units 1 and 2, Quad Cities Nuclear Power Station, Units 1 and 2, and Zion Nuclear Power Station, Units 1 and 2," January 5, 1998.
4. Atomic Energy Commission (AEC) SER, "Safety Evaluation by the Division of Reactor Licensing, U. S. Atomic Energy Commission In the Matter of Commonwealth Edison Company Quad-Cities Station, Units 1 and 2 Docket Nos. 50-254 and 50-265," August 25, 1971.
5. Ziemann, D.L., USNRC, to R.L. Bolger, ComEd, "Evaluation of the Potential for Low Pressure Coolant Injection (LPCI) Pump Damage Due to Operation In Excess of Design Flow During a Postulated Loss of Coolant Accident (LOCA)," January 4, 1977.
6. Lee, B., Jr. ComEd, to USNRC, "Amendment No. 13 to the application for construction permits and operating licenses for Quad-Cities Units 1 and 2 filed under AEC Dockets 50-254 and 50-265, respectively."
7. Lee, B., Jr. ComEd, to USNRC, "Amendment No. 16 to the application for construction permits and operating licenses for Quad-Cities Units 1 and 2 filed under AEC Dockets 50-254 and 50-265, respectively," February 8, 1971.
8. Lee, B., Jr. ComEd, to USNRC, "Amendment No. 17 to the application for construction permits and operating licenses for Quad-Cities Units 1 and 2 filed under AEC Dockets 50-254 and 50-265, respectively," March 1, 1971.
9. Abrell, G.A., ComEd, to D.L. Ziemann, USNRC, "Dresden Station Units 2 and 3, Quad-Cities Station Units 1 and 2 - Long Term Cooling Capability," August 2, 1976.
10. Pearce, L.W., ComEd, to USNRC, "Licensee Event Report (LER) 96-025, Revision 00, for Quad Cities Nuclear Power Station," Docket No. 50-254, January 22, 1997.
11. Quad Cities Station Units 1 and 2, "10CFR50.59 Safety Evaluation Number 97-001," January 10, 1997. (See memo dated June 30, 1998, "Containment Overpressure," to Document Control Desk from Robert M. Pulsifer.)