U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos:	50-254; 50-265
License Nos:	DPR-29; DPR-30
Report No:	50-254/96015(DRS);50-265/96015(DRS)
Licensee:	Commonwealth Edison Company (ComEd)
Facility:	Quad Cities Nuclear Power Station, Units 1 and 2
Location:	22710 206th Avenue North Cordova, IL 61242
Dates:	October 1 through November 6, 1996
Inspectors:	E. Duncan, Reactor Engineer L. Collins, Resident Inspector
Approved by:	Mark Ring, Chief, Lead Engineers Branch Division of Reactor Safety

EXECUTIVE SUMMARY

Quad Cities Nuclear Power Station, Units 1 & 2
NRC Inspection Report No. 50-254/96015(DRS);50-265/96015(DRS)

This inspection report contains the findings and conclusions for a special inspection conducted from October 1 through November 6, 1996, to review the following issues:

- Licensee Event Report (LER) 50-254/95002, "Improperly Sized Overloads Found on the Control Room Heating, Ventilation, and Air Conditioning (HVAC) System Due to Inadequate Original Design Analysis"

- Unresolved Item (URI) 92201-06, "Residual Heat Removal (RHR) Heat Exchanger (HX) Room Cooler Inoperable"

- Unresolved Item 50-254/94020-05, "RHR System Water Hammer Issue"

Assessment of Performance

- Immediate and long-term corrective actions for a problem regarding undersized thermal overloads on the "B" train control room HVAC booster fans and supply fan appeared adequate to prevent recurrence. A discrepancy regarding the evaluation of the safety significance of the problem between Dresden and Quad Cities was identified (Section E1.1).

- A licensee calculation concerning RHR room cooler operability assumed a non-conservative cooler inlet temperature. However, other conservative assumptions in the calculation coupled with the age of the problem and actions being taken to inspect the coolers every refueling outage led the inspectors to conclude that a further review of the calculations was not warranted (Section E1.2).

- The identification of weaknesses in the trending of RHR cooler differential pressure testing was an example of a weak performance trending program and was a deviation from corrective actions committed to in LERs 50-254/92008 and 50-265/92007 (Section E1.2).

- Procedure revisions concerning the potential for water hammer following a loss-of-offsite-power (LOOP) while in suppression pool cooling were appropriate, but were not initiated in a timely manner (Section E1.3).

Summary of Open Items

Deviations: Identified in Section E1.2
Violations: None identified
Unresolved Items: None Identified
Inspector Follow-up Items: None Identified
Non-Cited Violations: None Identified

REPORT DETAILS

III. Engineering

E1 Conduct of Engineering

E1.1 LER 50-254/95002, "Improperly Sized Overloads Found on the Control Room HVAC System Due to Inadequate Original Design Analysis"

a. Inspection Scope

The inspector reviewed LER 50-254/95002, "Improperly Sized Overloads Found on the Control Room HVAC System Due to Inadequate Original Design Analysis."

b. Observations and Findings

1. Description of the Event

On January 3, 1995, during a routine surveillance of the safety-related "B" train control room HVAC system at Dresden Station, the Air Filtration Unit (AFU) booster fan tripped unexpectedly. A root cause evaluation determined that the booster fan thermal overloads were undersized. In addition, the licensee determined that due to the improper sizing, the booster fans could fail to operate during a degraded voltage condition. The fans were subsequently declared inoperable and the overloads were replaced with the correct size.

Subsequently, Quad Cities was notified of the Dresden Station control room HVAC event, since the HVAC system at Quad Cities was similar to the Dresden design. Subsequently, the licensee determined that the same condition existed at Quad Cities for the "B" train control room HVAC booster fans as well as the "B" train HVAC supply fan. The "B" train of control room HVAC was declared inoperable on January 20, 1995, and the licensee entered a 14-day, dual unit, limiting condition for operation (LCO).

Setpoint changes were subsequently written to replace the thermal overloads for the control room HVAC booster fans and supply fan. The thermal overloads were replaced with properly sized parts, the system was retested satisfactorily, and the "B" train of control room HVAC was declared operable on January 21, 1995.

2. Control Room Ventilation System and Thermal Overload Device Descriptions

Control Room Ventilation System Description

The control room ventilation system at Quad Cities and Dresden consists of two trains. The "A" train is a nonsafety-related system built at the time of plant construction. It utilizes nonsafety-related power supplies, nonsafety-related service water for chiller cooling, and commercial components and design. The "B" train was installed in about 1982 in response to NUREG-0737. The "B" train was designed, procured, and installed as safety-related. A safety-related power supply, and safety-related backup cooling water supply was provided in the design. The "B" train also contains an air filtration unit (AFU) used to provide filtered makeup air to the control room emergency zone to pressurize the control room and minimize in-leakage following an accident. The AFU is required to meet general design criteria (GDC) 19 radiological limits for control room personnel following an accident.

Except for the limited redundancy within the "B" train, the control room ventilation system does not meet safety-related redundancy and single failure criteria. There is only one safety-related train powered from a single safety-related motor control center. If the accident included a loss of off-site power, the "A" train power and cooling water is unavailable and the recirculation dampers fail to align the "B" train air handling unit (AHU).

Thermal Overload Device Description

The most commonly used device for protection of small alternating current (AC) motors at operating loads is a thermal overload device. It simulates the temperature condition in the motor winding by means of current in a heating element which varies with motor current. In the event of a current of sufficient magnitude and duration which causes excessive heating of the motor winding, the heating element causes a control circuit contact to open for de-energizing the contactor in the motor circuit.

For continuous duty motors with a service factor of 1.0, which is the case for the control room HVAC fans in question, the thermal overloads should be selected such that 90 percent of the motor full load running current falls within the range specified in the manufacturer's table. In addition, the trip rating should be about 110 percent of the full load current for motors with a service factor of 1.0, but cannot exceed 130 percent of the full load current.

3. Root Cause

The licensee attributed the cause of the event to failure of the "B" control room HVAC design to properly consider operation under degraded voltage conditions during selection of the thermal overload devices. Specifically, although the thermal overload devices were originally selected using the Commonwealth Edison thermal overload selection guide, tolerances in the

thermal overload relay tripping characteristics were not appropriately considered in the guide. As a result, the thermal overload was undersized.

In addition, motors procured for the "B" train of control room HVAC were found with a nameplate rating of 480 Vac. Motors for this system should have been rated at 460 Vac. The motor vendor was contacted by the licensee to determine the impact of sustained operation at degraded voltage for the higher nominal voltage rating. The motor was determined to be acceptable. However, this error contributed to the problem, since higher normal operating currents due to the larger motor size decreased the margin to the thermal overload setpoint.

4. Safety Significance

The licensee determined that in the event of a design basis LOCA congruent with a degraded voltage condition, the "B" train of control room ventilation could have failed due to the undersized thermal overloads. If the "B" control room HVAC system failed, unfiltered air could have entered the control room, subjecting the operators to increased dose.

5. Licensee Corrective Actions

As part of the licensee's immediate corrective actions, setpoint changes were immediately written to replace the undersized thermal overloads for the affected control room HVAC booster fans and the supply fan.

As part of the licensee's long-term corrective actions, a search was performed for other safety-related, three phase induction motors rated for 480 Vac. No other motors were identified. In addition, the licensee investigated whether other undersized thermal overload devices were installed. None were identified.

At the time of the inspection, the licensee had engineering procedures and a tracking mechanism in place to evaluate load additions as they related to degraded voltage. Therefore, prior to any motor changes, nameplate data was to be evaluated for fit, form, and function. If an evaluation revealed that the change is not like-for-like, a design change was to be performed.

6. Inspector Review

The inspectors reviewed the licensee's immediate and long-term corrective actions and concluded that the actions taken in response to this event were appropriate. However, during a review of Dresden LER 50-237/95001, which reported the findings and conclusions at Dresden, the inspectors noted that although the event at Dresden appeared identical to the event at Quad Cities, the Dresden evaluation of safety significance was different. The Dresden LER stated that the safety significance of the event was minimal because a means was readily available for the operators to manually restart

the booster fans within a reasonable time period, and because only one of the fans would be needed at a time to support the operation of the control room HVAC system. The inspectors concluded that although problems concerning undersized thermal overloads were identified at both Dresden and Quad Cities, the licensees' evaluation of the safety significance of the events inexplicably differed from one another.

c. Conclusions

Immediate and long-term corrective actions for a problem regarding undersized thermal overloads on the "B" train control room HVAC booster fans and supply fan appeared adequate to prevent recurrence.

A discrepancy regarding the evaluation of the safety significance of the problem between Dresden and Quad Cities was identified. This LER is open pending a resolution of the differing evaluations.

E1.2 Unresolved Item 92201-06, "RHR Heat Exchanger Room Cooler Inoperable"

a. Inspection Scope

The inspectors reviewed URI 92201-06, "RHR Heat Exchanger Room Cooler Inoperable."

b. Observations and Findings

1. Description of the Event

As documented in a 1992 service water system operational performance inspection, the licensee identified significant flow restrictions on the 1A and 1B RHR room coolers following internal cooler inspections conducted in November 1990 and January 1991 in response to Generic Letter (GL) 89-13 concerns.

In addition, although the licensee determined that the flow restriction affected the heat removal capability beyond the cooler's 17 percent design margin, the licensee failed to recognize and subsequently address the plugging of the Unit 1 coolers as a potential operability issue. Consequently, required NRC notification of the degraded condition of the Unit 1 safety-related coolers was not promptly made. The inspection report also documented that similar coolers on Unit 2 were not inspected until March 1992. Inspection of the Unit 2 RHR room coolers also identified substantial plugging in excess of design margin limits. Following completion of those inspections, the licensee determined that both Unit 1 and Unit 2 RHR room coolers were potentially inoperable and generated Licensee Event Reports (LERs) 50-254/92008 and 50-265/92007 to report the findings.

The inspection report conclusions stated that the licensee failed to take appropriate corrective action to address the degraded Unit 1 RHR room coolers that were identified as plugged because timely action was not taken to inspect and evaluate the operability of the Unit 2 RHR room coolers. The inspectors also concluded that the Unit 2 RHR room coolers appeared to have been inoperable for about one year while Unit 2 was on line, which could have affected the operability of the RHR system during this period. As a result, URI 92201-06 was opened to track this issue.

In a letter dated July 14, 1992, which responded to URI 92201-06, the licensee stated that an engineering evaluation verified that the fouling of the RHR room coolers would not have prevented the RHR system from performing its immediate safety function.

2. Root Cause

The licensee identified that the RHR room coolers were fouled due to insufficient cleaning, since the coolers had not been inspected in more than ten years. Since regular inspection and cleaning was not required or performed for the coolers in over ten years, blockage occurred due to accumulation of silt and debris.

3. Licensee Corrective Actions

As part of the licensee's immediate corrective actions, the RHR room coolers were cleaned when the individual coolers were identified as fouled. This action ensured that the RHR room coolers would be capable of removing the design heat loads from the RHR corner rooms, and maintain the rooms below their equipment qualification (EQ) temperature limits.

In addition, the licensee made the following commitment in the July 14, 1992, letter which responded to URI 92201-06 and in the LERs which documented the fouling events:

- To prevent the recurrence of significant fouling due to long periods without cleaning, the station was to inspect the "A" and "B" RHR rooms coolers at least once per cycle through cycle 13 with a long-term inspection frequency to be determined prior to the cycle 14 refueling outage.

- A method of monitoring the room coolers was being implemented through the installation of pressure gauges on the cooling water piping at the inlet and outlet of the coolers. In addition, a procedure to trend and analyze these pressures was to be developed to ensure that if a cooler was becoming blocked, action could be taken before the design margin was exceeded.

4. Inspector Review

Corrective Actions Review

The inspectors reviewed the licensee's corrective actions and verified that the RHR room coolers were inspected at least once per cycle as committed to in the licensee's response to URI 92201-06. The inspectors noted that the results of those subsequent inspections identified some minor fouling which did not adversely impact cooler performance. The inspectors also determined that the licensee planned to conservatively continue to conduct RHR room cooler inspections every refueling outage beyond cycle 13.

The inspectors conducted a plant tour and verified that pressure gauges had been installed on the RHR room cooler cooling water piping. The inspectors reviewed the licensee's program developed to trend and analyze these pressures and noted the following weaknesses:

- At the time of the inspection, although surveillances to measure cooler differential pressure had been performed monthly, the data had not been entered into the trending system for the last 12 months. System engineering personnel subsequently determined that trending of the data was inadvertently discontinued following a turnover of responsibilities to another individual. The inspectors also determined that a procedure to trend and analyze these pressures had not been implemented as committed to in the subject LERs. The failure to accomplish this action is considered a deviation for which a Notice of Deviation is being issued (50-254/96015-01(DRS); 50-265/96015-01(DRS)).

  A concern regarding trending of plant parameters was identified during a July 1996 Engineering and Technical Support inspection documented in Inspection Report No. 50-254/96010(DRS); 50-265/96010(DRS). The inspectors concluded that identification of weaknesses in the trending of RHR cooler differential pressure testing results was another example of a weak trending program.

- The inspectors reviewed Quad Cities Operating Surveillance (QCOS) 5750-09, "Emergency Core Cooling System (ECCS) and Diesel Generator Cooling Water Pump (DGCWP) Cubicle Cooler Monthly Surveillance." This procedure was implemented to obtain RHR room cooler cooling water differential pressure data. During that review, the inspectors identified that on July 7, 1996, an incorrect 1A RHR room cooler differential pressure was recorded in QCOS 5750-09 due to an arithmetic error in calculating the difference between the inlet and outlet cooling water pressures. However, due to a weak operations review which failed to identify the error, and a weak trending process which failed to input the data into the trending program, the error went undetected, although the value recorded was

double the values recorded during the previous six months. In addition, the inspectors noted that QCOS 5750-09 failed to include acceptance criteria related to the measured differential pressures, which could have provided an additional opportunity to identify the error.

Walkdown Observations

The inspectors walked down portions of the RHR system, including the RHR room coolers. During the walkdown, the inspectors identified that RHR room cooler louvers were in some cases inadvertently mispositioned to block flow rather than direct flow, or in poor materiel condition due to being either bent or disconnected. Although the overall operability of the coolers did not appear to be impacted, the condition of the louvers indicated that actions to improve the materiel condition of the cooler louvers could benefit cooler performance. In addition, the inspectors noted housekeeping problems, such as graffiti and unnecessary materials in the rooms, including a large piece of garlock draped over a section of RHR piping.

Engineering Evaluation Review

The inspectors reviewed the licensee's engineering evaluation, which concluded that the room coolers would have performed their safety function. During that review, the inspectors identified that for the 2B RHR room cooler (worst case), the calculated heat removal was 333,539 british thermal units per hour (BTUs/hr), which slightly exceeded the RHR room design heat load of 330,000 BTUs/hr. However, the calculated heat removal was obtained by assuming a cooler inlet water temperature of 87°F, which was somewhat less than the Updated Final Safety Analysis Report (UFSAR) design temperature of 95°F. The licensee's response letter to URI 92201-06 discussed this assumption, and added that the maximum historical Mississippi river temperature recorded at the station was 88.7°F, with the majority of river water temperatures less than 86°F. The calculation also assumed a blockage of 40 tubes, although 38 tubes were identified as blocked during inspections of the 2B RHR room cooler.

The inspectors discussed this information with licensee personnel who stated that in addition to the factors discussed above, the calculations did not take credit for heat removal losses from natural circulation which are present in the 1A, 1B, and 2A RHR rooms due to the physical room configurations and the ability to obtain natural circulation heat removal in the 2B RHR room through removal of the RHR room floor plug.

The inspectors concluded that non-conservative assumptions were incorporated into the licensee's calculations. However, due to the age of the issue, calculational conservatisms, heat removal losses not taken credit for, and the licensee's actions to inspect RHR room coolers every refueling outage, a further review of the calculations was not warranted.

c. Conclusions

Although a licensee evaluation concerning RHR room cooler operability assumed a non-conservative cooler inlet temperature, other conservative assumptions coupled with the age of the problem and actions being taken to inspect the coolers every refueling outage led the inspectors to conclude that further effort on this issue was not warranted.

The inspectors concluded that the failure to implement a procedure to trend and analyze RHR room cooler cooling water differential pressures was a deviation from corrective actions committed to in LERs 50-254/92008 and 50-265/92007. In addition, the identification of weaknesses in the trending of RHR room cooler differential pressure testing results coupled with trending program weaknesses identified in Inspection Report No. 50-254/96010(DRS);50-265/96010(DRS) indicated a weak performance trending program.

Unresolved Item 92201-06 is closed.

E1.3 Unresolved Item 50-254/94020-05, "RHR System Water Hammer Issue"

a. Inspection Scope

The inspectors reviewed URI 50-254/94020-05, "RHR System Water Hammer Issue," related to the potential for water hammer in the RHR system if a loss-of-coolant-accident (LOCA) concurrent with a loss-of-offsite-power (LOOP) were to occur while the system was aligned for suppression pool cooling (SPC).

b. Observations and Findings

1. Description of the Event

As documented in Inspection Report No. 50-254/93026(DRP); 50-265/93026(DRP), the licensee's evaluation of Information Notice (IN) 87-10, "Potential For Water Hammer During Restart of Residual Heat Removal Pumps," concluded that followup actions were not required and provided an explanation to support that position. However, the inspectors reviewed the licensee's explanation and concluded that the evaluation performed was inadequate and a potential existed for a water hammer under the stated conditions. As a result, inspection followup item (IFI) 50-254/265-93026-03 was opened.

As documented in Inspection Report No. 50-254/94016(DRP); 50-265/94016(DRP), the licensee re-evaluated IN 87-10 and concluded that the potential for a water hammer was considered remote and that an analysis had been performed which indicated that if a water hammer were to occur at the time emergency core cooling was required, the system would still perform its design function. As a result, IFI 50-254/265-93026-03 was closed.

As documented in Inspection Report No. 50-254/94020(DRS); 50-265/94020(DRS),the inspectors re-opened this issue following concerns raised during an Engineering and Technical Support (E&TS) inspection. During that inspection, the inspectors identified that although the licensee's evaluation of IN 87-10 concluded that the residual heat removal (RHR) system would have only minimal susceptibility to water hammer, in fact, a substantial loss of water could occur given the initial conditions prescribed by IN 87-10, resulting in a severe water hammer. In addition, the licensee was unable to retrieve the water hammer analysis which demonstrated that if a water hammer were to occur, the emergency core cooling system (ECCS) would still function as designed. As a result, IFI 50-254/94020-05(DRS)was opened.

During this inspection, the licensee provided General Electric (GE) report NEDC-32513, "Suppression Pool Cooling and Water Hammer," dated December 29, 1995. This report was prepared for the Boiling Water Reactor Owners' Group (BWROG) Residual Heat Removal/Suppression Pool Cooling (RHR/SPC) Committee to address the concerns raised by IN 87-10. In that report, the following conclusions were reached:

- The intent of the original LOOP licensing basis was to "assume offsite power was not available" and did not require that a LOOP be considered mechanistically in the licensing basis assumptions.

- The probability of occurrence of the postulated event scenario of a LOOP/LOCA with one or more RHR loops in the SPC mode that leads to water hammer was extremely low (< 10E-6 per year).

- Predictions of piping system response due to water hammer loads tends to be unrealistically conservative because of conservatisms in the modeling and assumptions. As a result, actual water hammer events indicate that the damage is less severe than predictions and usually limited to pipe hangars and mounts.

- Given the extremely low probability of the postulated concurrent LOOP/LOCA scenario that leads to a water hammer, and the low likelihood that the water hammer would totally incapacitate the affected system, a significant public risk did not exist and substantial additional effort for resolution may not be supported by a cost/benefit analysis.

2. Information Notice 87-10 Description

Information Notice 87-10, "Potential for Water Hammer During Restart of Residual Heat Removal Pumps," was issued on February 11, 1987, to alert licensee's of the potential for water hammer in the RHR system. The specific condition of concern involved a design basis LOCA coincident with a LOOP, with one or more RHR loops in the suppression pool cooling mode.

During the power loss and subsequent valve re-alignment, portions of the RHR system could void because of the drain down to the suppression pool as a result of elevation differences. A water hammer may occur in those RHR loops that were in the SPC mode when the RHR pumps restart after the diesel generators re-energize their respective buses. As a result, the integrity of the RHR system could be in jeopardy, which could endanger all modes of RHR, including low pressure coolant injection.

3. Licensee Corrective Actions

The inspectors determined that although no system modifications were being considered, the licensee planned to revise appropriate procedures to reduce the probability of this event from occurring. These planned procedure revisions included caution statements to warn operators of the potential consequences in the event of a LOOP while in suppression pool cooling, as well as to allow only one loop of RHR to operate in suppression pool cooling at a time.

4. Inspector Review

The inspectors reviewed the licensee's corrective actions concerning the proposed procedure changes. The proposed changes appeared appropriate. However, the inspectors concluded that the licensee's actions to revise the procedures were not timely, since the licensee was aware that they were susceptible to water hammer following discussions in 1994.

In addition, the inspectors questioned whether GE report NEDC-32513 was accurate concerning a conclusion that the intent of the licensing basis did not require that a LOOP be considered mechanistically in the licensing basis assumptions. This question has been forwarded to NRC headquarters for technical review.

c. Conclusions

A question concerning the intent of the original licensing basis was forwarded to NRR for review. Procedure revisions concerning the potential for water hammer following a LOOP while in suppression pool cooling were appropriate, but were not initiated in a timely manner.

Unresolved Item 50-254/94020-05(DRS),"RHR System Water Hammer Issue," remains open pending a technical review by NRC headquarters staff regarding the LOOP licensing basis.

E2 Engineering Support of Facilities and Equipment

E2.1 Updated Final Safety Analysis Report (UFSAR) Review

A recent discovery of a licensee operating their facility in a manner contrary to the Updated Final Safety Analysis Report (UFSAR) description highlighted the need for a special focused review that compares plant practices, procedures and/or parameters to the UFSAR descriptions. While performing the inspections discussed in this report, the inspectors reviewed the applicable portions of the UFSAR that related to the areas inspected. The inspectors verified that the UFSAR wording was consistent with the observed plant practices, procedures and/or parameters.

V. Management Meetings

X1 Exit Meeting Summary

The inspectors presented the preliminary inspection results to members of licensee management on October 3, 1996. In addition, the final inspection results were presented on November 6, 1996. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

D. Craddick, System Engineering Supervisor
R. Baumer, Regulatory Assurance
R. Luebbe, System Engineering
W. Quinn, System Engineering
R. Robbins, System Engineering
B. Strub, System Engineering

INSPECTION PROCEDURES USED

IP 37551: On Site Engineering
IP 92700: Onsite Followup of Written Reports of Nonroutine Events at Power Reactor Facilities

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

DEV	50-254/96015-01(DRS); 50-265/96015-01(DRS)	Deviation from commitment to trend RHR room cooler differential pressure and to develop a procedure for this trending

Closed

URI 92201-06:	RHR Heat Exchanger Room Cooler Inoperable

Discussed

LER 50-254/95002:	Improperly Sized Overloads Found on the Control Room HVAC System Due to Inadequate Original Design Analysis
URI 50-254/94020-05(DRS):	RHR System Water Hammer Issue

LIST OF ACRONYMS USED

AC	Alternating Current
AFU	Air Filtration Unit
AHU	Air Handling Unit
BTU	British Thermal Unit
BTUs/hr	British Thermal Units Per Hour
BWROG	Boiling Water Reactor Owners' Group
ComEd	Commonwealth Edison Company
DGCWP	Diesel Generator Cooling Water Pump
°F	Degrees Fahrenheit
ECCS	Emergency Core Cooling System
E&TS	Engineering and Technical Support
EQ	Equipment Qualification
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
GE	General Electric
GL	Generic Letter
HVAC	Heating, Ventilation, and Air Conditioning
HX	Heat Exchanger
IFI	Inspection Followup Item
IN	Information Notice
IR	Inspection Report
LCO	Limiting Condition for Operation
LER	Licensee Event Report
LOCA	Loss-Of-Coolant-Accident
LOOP	Loss-Of-Offsite-Power
MCC	Motor Control Center
QCOS	Quad Cities Operating Surveillance
RHR	Residual Heat Removal
SPC	Suppression Pool Cooling
TS	Technical Specification
UFSAR	Updated Final Safety Analysis Report
URI	Unresolved Item
Vac	Volts Alternating Current
VIO	Violation