October 30, 2000

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

SUBJECT: QUAD CITIES-NRC SUPPLEMENTAL INSPECTION REPORT 50-254/200013(DRP); 50-265/2000013(DRP)

Dear Mr. Kingsley:

By letter dated May 18, 2000, you were informed that the NRC would conduct a supplemental inspection using Inspection Procedure 95002 at your Quad Cities Nuclear Power Station for a degraded Mitigating Systems Cornerstone due to one YELLOW performance indicator. Additionally by a letter dated August 9, 2000, you were informed that the NRC would conduct a supplemental inspection using Inspection Procedure 95001 at the Quad Cities Nuclear Power Station to examine safety system functional failure issues which caused a WHITE performance indicator for both units. The enclosed inspection report presents the results of those supplemental inspections which were conducted as a single, combined team inspection. The results of this inspection were discussed on September 15, 2000, with Mr. J. Dimmette and other members of your staff. We also held a public meeting with you and your staff on July 14, 2000, at the plant site to discuss your corrective actions associated with the causes of the YELLOW and WHITE performance indicators.

This supplemental inspection was an examination of activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. Within these areas, the inspection consisted of a selected examination of procedures and representative records, observations of activities, and interviews with personnel. Specifically, the inspectors reviewed the issues, the circumstances, and the resulting root cause evaluations surrounding the reported YELLOW performance indicator for the Unit 1 high pressure coolant injection unavailability, reported in the first quarter 2000 performance indicator submittal. The resultant degraded Mitigating Systems Cornerstone for Unit 1 was reviewed in detail per NRC Inspection Procedure 95002. In addition, the inspectors reviewed the issues, circumstances and root cause evaluations for the WHITE performance indicators for Unit 1 and Unit 2 safety system functional failures reported in the second quarter 2000 performance indicator submittal. This portion of the supplemental inspection was performed using Inspection Procedure 95001 to review the details regarding root cause, corrective action, and extent of condition actions taken by ComEd.

Based on the results of this inspection, the NRC determined that one violation of NRC requirements occurred. The station failed to take timely corrective action on a design deficiency with the high pressure coolant injection system for both units. This issue has been entered into your corrective action program. This issue is also listed in the summary of findings and discussed in this report. This violation is being treated as a non-cited violation (NCV), consistent with Section VI.A.1 of the Enforcement Policy. This issue was considered to be of very low risk significance (GREEN) because it would not have prevented the system from functioning.

If you contest the non-cited violation, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the Nuclear Regulatory Commission, ATT.: Document Control Desk, Washington DC 20555-0001, with a copy to the Regional Administrator, Region III, Resident Inspector and the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available **electronically** for public inspection in the NRC Public Document Room **or** from the *Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from* the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room).

Sincerely,

Original signed by
Geoffrey E. Grant, Director

Geoffrey E. Grant, Director
Division of Reactor Projects

Docket Nos. 50-254; 50-265
License Nos. DPR-29; DPR-30

Enclosures:
1. Inspection Report 50-254/2000013(DRP); 50-265/2000013(DRP)
2. Licensee September 15, 2000, Exit Presentation Slides

See Attached Distribution

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REGION III

Docket Nos:	50-254; 50-265
License Nos:	DPR-29; DPR-30
Report No:	50-254/2000013(DRP); 50-265/2000013(DRP)
Licensee:	Commonwealth Edison Company (ComEd)
Facility:	Quad Cities Nuclear Power Station, Units 1 and 2
Location:	22710 206th Avenue North Cordova, IL 61242
Dates:	August 14 through September 15, 2000
Inspectors:	C. Miller, Senior Resident Inspector W. Scott, Reactor Engineer A. Dunlop, Reactor Engineer P. Lougheed, Reactor Engineer R. Ganser, Illinois Department of Nuclear Safety
Approved by:	Mark Ring, Chief Reactor Projects Branch 1 Division of Reactor Projects

NRC's REVISED REACTOR OVERSIGHT PROCESS

The federal Nuclear Regulatory Commission (NRC) recently revamped its inspection, assessment, and enforcement programs for commercial nuclear power plants. The new process takes into account improvements in the performance of the nuclear industry over the past 25 years and improved approaches of inspecting and assessing safety performance at NRC licensed plants.

The new process monitors licensee performance in three broad areas (called strategic performance areas): reactor safety (avoiding accidents and reducing the consequences of accidents if they occur), radiation safety (protecting plant employees and the public during routine operations), and safeguards (protecting the plant against sabotage or other security threats). The process focuses on licensee performance within each of seven cornerstones of safety in the three areas:

Reactor Safety

- Initiating Events
- Mitigating Systems
- Barrier Integrity
- Emergency Preparedness

Radiation Safety

- Occupational
- Public

Safeguards

- Physical Protection

To monitor these seven cornerstones of safety, the NRC uses two processes that generate information about the safety significance of plant operations: inspections and performance indicators. Inspection findings will be evaluated according to their potential significance for safety, using the Significance Determination Process, and assigned colors of GREEN, WHITE, YELLOW or RED. GREEN findings are indicative of issues that, while they may not be desirable, represent very low safety significance. WHITE findings indicate issues that are of low to moderate safety significance. YELLOW findings are issues that are of substantial safety significance. RED findings represent issues that are of high safety significance with a significant reduction in safety margin.

Performance indicator data will be compared to established criteria for measuring licensee performance in terms of potential safety. Based on prescribed thresholds, the indicators will be classified by color representing varying levels of performance and incremental degradation in safety: GREEN, WHITE, YELLOW, and RED. GREEN indicators represent performance at a level requiring no additional NRC oversight beyond the baseline inspections. WHITE corresponds to performance that may result in increased NRC oversight. YELLOW represents performance that minimally reduces safety margin and requires even more NRC oversight. And RED indicates performance that represents a significant reduction in safety margin but still provides adequate protection to public health and safety.

The assessment process integrates performance indicators and inspection so the agency can reach objective conclusions regarding overall plant performance. The agency will use an Action Matrix to determine in a systematic, predictable manner which regulatory actions should be taken based on a licensee's performance. The NRC's actions in response to the significance (as represented by the color) of issues will be the same for performance indicators as for inspection findings. As a licensee's safety performance degrades, the NRC will take more and increasingly significant action, which can include shutting down a plant, as described in the Action Matrix.

More information can be found at: http://www.nrc.gov/NRR/OVERSIGHT/index.html.

SUMMARY OF FINDINGS

IR05000254-00-13, 05000265-00-13 on 8/14-09/15/2000; Commonwealth Edison; Quad Cities Nuclear Power Plant, Units 1 & 2. Supplemental Inspection - Degraded Cornerstone

Cornerstone: Mitigating Systems

This supplemental inspection was performed to assess the licensee's evaluation and corrective actions associated with a Unit 1 degraded Mitigating Systems Cornerstone due to one YELLOW performance indicator for high pressure injection unavailability and one WHITE performance indicator each for Unit 1 and Unit 2 safety system functional failures.

YELLOW Performance Indicator for High Pressure Coolant Injection Unavailability

The Unit 1 high pressure coolant injection unavailability resulted from a failure of the auxiliary oil pump to remain on during a start of the system, which was discovered on March 21, 2000. The licensee determined that the primary root cause was "inadequate operating margin" between the system header pressure which was controlled by a pressure regulating valve, and the trip setpoint for pressure switch PS-4, which automatically turned the pump off. Contributing causes included by the licensee were:

a. leakage through the 1-2399-43 check valve in the high pressure coolant injection oil system,
b. variance in control oil header pressures at different locations in the control oil header, and
c. emergency oil pump auto-starts which occurred during auxiliary oil pump startups.

Licensee corrective actions included checking and adjusting the setpoints for auxiliary oil system operation, and requiring quarterly testing. Corrective actions also included test changes and installation of test instrumentation to ensure proper system pressure until a modification could be performed which would prevent the auxiliary oil pump from tripping off during initial system startup. Design Changes 9900079 and 9900080 incorporated the modification and were scheduled to be completed for both units by the end of October 2000.

The inspectors considered the licensee's root cause investigation and proposed corrective actions adequate to correct the problem with the auxiliary oil pump cycling. Once all corrective actions are completed for both units, the YELLOW performance indicator associated with Unit 1 high pressure coolant injection unavailability will only be considered in assessing plant performance for a total of four quarters in accordance with the guidance in Inspection Manual Chapter 0305 "Operating Reactor Assessment Program" and appropriate performance indicator guidelines.

However, some weaknesses were noted in the licensee's actions regarding contributing causes and extent of condition. The root cause evaluation for the March 21, 2000, high pressure coolant injection auxiliary oil pump cycling failed to address previous poor corrective actions as a contributing cause to the event.

The inspectors also found that the extent of condition reviews performed by the licensee, while thorough in some areas, were weak in others. Weak areas included: setpoint operating margin on the reactor core isolation cooling system, depth of the extent of condition review for some components, and failure to recognize some previously identified system design problems such as missing seal-in logic for the high pressure coolant injection system. However, the inspectors considered the overall assessment to be acceptable. Licensee efforts to correct these issues will be reviewed during the problem identification and resolution inspection in August 2001.

- GREEN One corrective action problem was found on August 16, 2000,and involved a previously identified design deficiency with the high pressure coolant injection system. Problem Identification Form Q1997-04485 documented that the auto initiation signal for high pressure coolant injection did not electrically seal in as described in the updated final safety analysis. However, the tracking item for correcting this problem was closed without corrective action being completed. Condition Report Q2000-02954 was written to again track corrective actions to this problem. This was considered a Non-Cited Violation (NCV) of Criterion XVI, "Corrective Action," of 10 CFR 50, Appendix B. Inspectors considered this problem to be of very low risk significance (GREEN) since it would not have prevented the system from starting automatically or being initiated manually.

WHITE Performance Indicators for Units 1 and 2 Safety System Functional Failures

The licensee's August 14, 2000, root cause report for the high number of safety system functional failures on both units listed three root causes: inadequate knowledge of complex systems, a system vice functional focus, and inadequate integration of the new NRC inspection program into the station's processes. Corrective actions listed by the licensee included: Maintenance department clarification of expectations for troubleshooting, Engineering department revision of a troubleshooting procedure to require formal troubleshooting plans, Regulatory Affairs requirement for root cause evaluation of any performance indicator which is "threatened" (less than 50 percent margin to the WHITE threshold), Regulatory Affairs requirement for root cause evaluations to include a section on cumulative effects of the system failure on a "threatened" performance indicator, Regulatory Assurance modification of corrective action program to implement root cause requirements for a "threatened" performance indicator, Plant Health Committee requirement for monthly review of performance indicators, development or revision of process to address a cumulative focus on NRC Mitigating Systems Cornerstone and functional health, Engineering action to expand use of formal troubleshooting techniques and enhance troubleshooting skills and troubleshooting procedure.

The inspectors found no current concerns with the individual root cause reports for these issues. Inspectors validated the licensee assertion that poor troubleshooting and poor root causes were an issue at Quad Cities. Two of the ten events from the individual root cause evaluations were repeats of earlier events, and the root cause efforts were not effective initially. Inspectors found weaknesses in the overall root cause report for the multiple safety system functional failures as follows:

- The overall root cause evaluation failed to incorporate one of two February 2000 events. Human performance events did not get full coverage in the overall root cause, some events for the safety system functional failures involving human performance were not included.

- The evaluation was focused on problems which would cause an NRC performance indicator change, and to a lesser amount on why such a large number of failures were occurring at Quad Cities. The report listed actions to review another method for trending cumulative impact of failures, but another method was not ready for review at the end of the inspection. The inspectors determined that the licensee's search for similar failures focused on the recently instituted category of "performance indicator" and thereby eliminated a number of previous safety system functional failures that occurred in 1997 and 1998.

- The corrective action for troubleshooting failed to incorporate the operations department, and only focused on maintenance and engineering.

Although the licensee did not entirely agree with all of the weaknesses identified by the inspectors, nevertheless, the licensee revised several of the root cause evaluations to ensure appropriate actions were developed to address the inspector's concerns.

Report Details

01 Inspection Scope

This supplemental inspection was performed in two parts in accordance with Inspection Procedures 95002 and 95001. Inspectors used the 95002 procedure to assess the licensee's evaluation and corrective actions associated with a degraded Mitigating Systems Cornerstone for Unit 1. The cornerstone was considered degraded due to a YELLOW performance indicator for high pressure coolant injection system unavailability. Inspectors reviewed Root Cause Report Q2000-01214, "Unit 1 High Pressure Coolant Injection Subsystem Auxiliary Oil Pump Failure to Continue Running on an Auto-initiation Signal During High Pressure Coolant Injection Logic Functional Test Caused by Inadequate Design Margin on the Control Oil System, August 11, 2000." The inspectors also reviewed Licensee Event Report 50-254/00-03 for the high pressure coolant injection pump failure to start and the licensee's Focused Area Self-Assessment Report for Degraded Mitigating Systems Cornerstone, Revision 3, dated August 12, 2000.

In addition, a supplemental inspection was performed in accordance with Inspection Procedure 95001 to assess the licensee's evaluation and corrective actions for a WHITE performance indicator for safety system functional failures on both Unit 1 and Unit 2. The WHITE performance indicators resulted from seven safety system functional failures on each unit arising from ten failures which occurred between September 1999 and May 2000. These ten failures included four events which affected both units and two events which were repeats of earlier failures. Each of these events was assessed by both the licensee and the resident inspectors as individually being of very low risk significance. However, the failures contributed to the performance indicator for safety system functional failures changing to WHITE for both units during the second quarter of 2000. The root cause report for the WHITE performance indicator, individual root causes, and the Trend Investigation Report for Human Performance errors from January through June 2000 (AT31648-0) were reviewed. A list of the events which contributed to the performance indicator change is provided below, along with a summary of the root cause and the NRC inspection reports where the event was previously reviewed.

08/99 Unit 2 Reactor Core Isolation Cooling Overspeed Trip. The overspeed trip was traced to a failed resistor. This issue was discussed in Inspection Reports 50-254/99018; 50-265/99018, 50-254/99020; 50-265/99020, and 50-254/2000003; 50-265/2000003.

09/99 Unit 1 High Pressure Coolant Injection Steam Supply Outboard Containment Isolation Valve Fails to Close. The failure was initially determined to be caused by a failed control switch; however, following the October 1999 failure, the licensee determined that mechanical binding of the direct-current electrical contactor was at fault. This issue was discussed in Inspection Report 50-254/99023; 50-265/99023.

09/99 Control Room Emergency Ventilation System Air Filtration Unit Flow Above Technical Specification Limits (applies to both units). The licensee ascribed the failure to "inadequate knowledge of a complex system" because of multiple actions which contributed to the event. This issue was discussed in Inspection Reports 50-254/99020; 50-265/99020 and 50-254/2000003; 50-265/2000003.

10/99 Unit 1 High Pressure Coolant Injection Steam Supply Outboard Containment Isolation Valve Fails to Close. This failure was a repeat of the September 1999 failure. Following this event, the licensee determined that mechanical binding was preventing the direct-current electrical contactor from operating properly. This issue was discussed in Inspection Report 50-254/99023; 50-265/99023.

11/99 Unit 2 High Pressure Coolant Injection Vacuum Breaker Fails to Close. The licensee was unable to precisely determine why the valve failed to close; but foreign material on the valve seat was suspected. This issue was discussed in Inspection Report 50-254/2000001; 50-265/2000001.

12/99 Control Room Emergency Ventilation System Refrigeration Condensing Unit Breaker Trip (applies to both units). This failure was determined to be due to a loose screw on the control switch; however, following the May 2000 failure, the licensee discovered that the cam follower portion of the switch was defective. This issue was discussed in Inspection Report 50-254/99025; 50-265/99025.

01/00 Safe Shutdown Makeup Pump Valve Fails in Mid-Position (applies to both units). This failure was caused by improper staking of the valve during maintenance. This issue was discussed in Inspection Reports 50-254/2000001; 50-265/2000001and 50-254/2000005; 50-265/2000005.

02/00 Unit 2 High Pressure Coolant Injection Pump Fails to Start and Inadequate Venting. Because the venting issue was discovered during a return to service following the failure of the pump to start, these are considered one safety system functional failure. The pump's failure to start was due to incomplete maintenance work, while the inadequate venting was traced to an ineffective procedure. This issue was discussed in Inspection Report 50-254/2000001; 50-265/2000001.

03/00 Unit 1 High Pressure Coolant Injection Auxiliary Oil Pump Fails. Although this event caused a safety system functional failure, it is discussed separately in this report. It is included in this list only for completeness. This issue was discussed in Inspection Reports 50-254/2000001; 50-265/2000001, 50-254/2000003; 50-265/2000003, and 50-254/2000005; 50-265/2000005.

05/00 Control Room Emergency Ventilation System Refrigeration Condensing Unit Breaker Trip. This was a repeat of the December 1999 event and applied to both units. Following this failure, the licensee determined that the failure was actually caused by a defective cam follower in the control switch, which contributed to the loose screw identified in December 1999. This issue had not been previously discussed in an NRC inspection report.

This report is organized by the specific inspection requirements of Inspection Procedures 95001 and 95002 and Inspection Manual Chapter 0610*, the requirements are noted in italics in the following sections. Each requirement was answered in two parts. The first part relates to the high pressure coolant injection unavailability (YELLOW), and the second part corresponds to the issues involving safety system functional failure performance (WHITE).

02 Evaluation of Inspection Requirements

02.01 Problem Identification

a. *Determine that the evaluation identifies who (i.e. licensee, self revealing, or NRC), and under what conditions the issue was identified.*

a.1 YELLOW The YELLOW performance indicator resulted from cycling of the Unit 1 high pressure coolant injection auxiliary oil pump during performance of the high pressure coolant injection logic functional test on March 21, 2000. The high pressure coolant injection auxiliary oil pump was observed to start and stop numerous times when given a simulated auto-start signal. The auxiliary oil pump control switch was taken to manual to maintain the pump in a running condition, and the logic test was stopped. The high pressure coolant injection system was declared inoperable, and Problem Identification Form Q2000-01214 was initiated to document the issue.

Nuclear Work Request 990156693 was written to adjust oil pressure regulating valve 1-2399-PRV3. The valve was adjusted to maintain pressure 4 pounds per square inch, gauge (psig) lower. The Unit 1 high pressure coolant injection system was returned to operable status on March 23, 2000, based on the PRV-3 adjustment, and on the subsequent successful testing.

a.2 WHITE All the individual events involved with the safety system functional failures were self-revealing during surveillance testing. This was addressed in each evaluation. For the repeat events, a successful surveillance test was performed only to have the failure recur during the next test. The overall root cause was identified by the licensee when it came time to report the Performance Indicator data.

b. *Determine that the evaluation documents how long the issue existed and prior opportunities for identification.*

b.1. YELLOW The high pressure coolant injection auxiliary oil pump failure was self identified. Prior to this discovery, successful auxiliary oil pump auto-start was last verified by test in December 1998. Because the exact time of failure was unknown, an estimated unavailability time was used based on one half the time between the last successful test and the discovery of the failure. Opportunities for prior identification of similar issues are outlined below:

<u>April 1987</u> - During special testing of the high pressure coolant injection system at Dresden Unit 2, the auxiliary oil pump tripped on three separate occasions. Investigations conducted by engineers and the vendor determined that operation of the emergency oil pump concurrent with the auxiliary oil pump running could cause oil pressure buildup in the low-pressure oil header. Under this condition, the auxiliary oil pump could trip due to inadequate design margin between the system oil pressure and the PS-4 auxiliary oil pump trip setpoint. An engineering evaluation was performed, and the setpoint of PS-4 was changed from 52 psig to 60 psig at Dresden and Quad Cities. In addition, operating experience data indicated that the control oil header pressure at the PS-4 location was 6 to 7 psig higher than at other system locations. An evaluation concluded that the behavior of the systems at Dresden and Quad Cities were completely

different. A recommendation was made to perform an evaluation by the vendor to better understand system operation specific to premature auxiliary oil pump trips. This evaluation was apparently never performed.

January 1996 – During performance of QCOS 2300-13, “High Pressure Coolant Injection Manual Initiation Test,” the Unit 1 high pressure coolant injection received an overload alarm from a relay in the auxiliary oil pump breaker. Additionally, the auxiliary oil pump was observed to cycle on and off several times. Testing of the Unit 1 high pressure coolant injection oil system showed that a combination of the pressure regulating valve PRV-3 being out of adjustment, and the trip pressure switch PS-4 being set to the low end of its setpoint tolerance caused the auxiliary oil pump to trip. During the investigation, it was found that pressure gauge PG-5, which was used to adjust PRV-3, was out of adjustment and read low by approximately 4 psig. Based on the above information, the root cause was determined to be inadequate preventive maintenance and/or trending of the high pressure coolant injection oil system for the regulating valves, pressure switches and instrumentation. As part of the corrective action from this event, a trending program was developed to monitor high pressure coolant injection system oil pressures.

December 1998 – The diaphragm in pressure regulating valve PRV-3 was replaced during the refueling outage, and the valve setpoint was set at the high end of its acceptable band. No formal engineering evaluation was performed at this time to justify setting the regulating valve to the high end of the band.

April 1999 – PRV-3 drifted up 1 psig between December 1998 and April 1999. This was identified in the high pressure coolant injection system oil pressure trending program. Since there were no formal acceptance limits for action in the high pressure coolant injection system oil trending program, no action was taken to evaluate or correct this instrument drift. In the 2000 high pressure coolant injection root cause evaluation, the licensee stated that this higher than normal setpoint may have caused the auxiliary oil pump to trip in the recent March 21, 2000, event.

May 1999 – High pressure coolant injection operating experience (OPEX) items for Quad Cities and Dresden Stations were reviewed as corrective action for a previous reactor trip. Over 600 high pressure coolant injection items were reviewed as part of this effort to determine if they impacted the system. The actions taken as a result of the OPEX, were reviewed, and judged as to whether the actions were sufficient.

This evaluation was focused on specific problems that caused the events versus the collective effects of these events.

b.2. WHITE The licensee was able to specifically determine how long the issue existed for the September 1999 control room emergency ventilation system and the February 2000 high pressure coolant injection system events. The remaining root cause evaluations indicated that the period of occurrence could not be exactly determined, but a reasonable estimate of occurrence was provided. The inspectors confirmed that the licensee appropriately considered prior opportunities to identify the conditions in each of the root causes.

c. *Determine that the evaluation documents the plant specific risk consequences (as applicable) and compliance concerns associated with the issue.*

c.1. YELLOW Inspectors verified that risk considerations were appropriate. Although the high pressure coolant injection system auxiliary oil pump affected the ability to automatically start high pressure coolant injection, the risk was shown to be small (less than 1E-6). Operator action to place the auxiliary oil pump in manual may have corrected the problem in time for the system to provide adequate injection. Even with the loss of high pressure coolant injection, there were other systems sufficient to provide core injection, both at high pressure and low.

c.2. WHITE The plant specific risk consequences of each event were evaluated in the overall root cause report and determined to be low. In the overall root cause, the licensee also evaluated specific combinations of events and found them to be of low risk significance. This conclusion agreed with the risk assessments done for the individual events, as documented in the inspection reports above. While the May 2000 event was not assessed in a previous inspection report, the inspectors noted that it was a repeat of the December 1999 event, which was assessed. The licensee declared equipment inoperable, as appropriate for each failure. Technical Specification requirements were met in all cases and the equipment was successfully tested and returned to service within allowed outage times.

02.02 *Root Cause and Extent of Condition Evaluation*

a. *Determine that the problem was evaluated using a systematic method to identify root causes and contributing causes.*

a.1. YELLOW The licensee followed procedure CAP-3, "Root Cause Investigation and Report Handbook," to evaluate this issue using a systematic method to identify root cause and contributing cause. The Kepner-Tregoe analysis was used to arrive at the cause of the event, and a "Why" staircase was utilized to determine the reason for the cause. The procedures required conducting interviews with key personnel, data collection, document review, and the preservation of physical evidence associated with the issue.

a.2. WHITE The licensee followed the corrective action program procedure and the root cause investigation and report handbook regarding preparation of root causes. In each root cause report, the licensee documented the systematic method used to perform the root cause. These included event and causal factor charting, barrier analysis, Kepner-Tregoe analysis and Taproot analysis. The procedure and handbook required establishing a root cause team, conducting interviews with key personnel in a timely manner and gathering information. At least one member of the team was required to be trained in root cause analysis techniques.

b. *Determine that the root cause evaluation was conducted to a level of detail commensurate with the significance of the problem.*

b.1 YELLOW The licensee's root cause evaluations were thorough and conducted to a level of detail commensurate with the significance of the problem. Section 2.03 of this report documents a weakness in establishing contributing causes for this event. The primary root cause for the high pressure coolant injection auxiliary oil pump event was determined to be “inadequate operating margin” between the system header pressure and the PS-4 trip setpoint. Contributing causes included:

c. leakage through the 1-2399-43 check valve in the high pressure coolant injection oil system,
d. variance in control oil header pressures at different locations in the control oil header, and
c. emergency oil pump (EOP) auto-starts which occur during auxiliary oil pump startups.

b.2. WHITE The August 14, 2000, report for the overall root cause performed for the high number of safety system functional failures on both units listed three root causes: inadequate knowledge of complex systems, a system vice functional focus, and the inadequate integration of the new NRC inspection program into the station’s processes.

Although each of the individual root cause evaluations were generally of sufficient detail, inspectors found the overall root cause report for the multiple safety system functional failures appeared to have some weaknesses which could degrade the effectiveness of the corrective actions. The evaluation appeared to focus on the question "why did the performance indicator change color" rather than on the underlying "why was there an abnormally high number of safety system functional failures?" Additionally, the inspectors noted that the overall root cause evaluation failed to incorporate the inadequate venting portion of the February 2000 event. The licensee included this issue in Condition Report Q2000-02993 and determined that the root cause was covered by the identified causal factors.

During review of the individual root cause evaluations for the safety system functional failures on both units, the inspectors determined that the following common causes factored into a number of the events:

- Ineffective troubleshooting applied to the September 1999 high pressure coolant injection system event and the December 1999 control room emergency ventilation system event.

- Inadequate procedures contributed to the September and October 1999 high pressure coolant injection events, the September 1999 control room emergency ventilation system event, the January 2000 safe shutdown makeup pump event, and the February 2000 inadequate venting.

- Failed components contributed to the August 1999 reactor core isolation cooling event, the September 1999 high pressure coolant injection event and the December 1999 and May 2000 control room emergency ventilation system events.

- Human performance contributed to the September 1999 control room emergency ventilation system event and the February 2000 high pressure coolant injection failure to complete all maintenance work. Human performance also affected the licensee's ability to determine the root cause for the November 1999 high pressure coolant injection system event in that operators failed to preserve system condition so that troubleshooting could occur on the failed valve.

- Training issues contributed to the September 1999 control room emergency ventilation system event and the February 2000 high pressure coolant injection system event.

The licensee's overall root cause evaluation identified the first two of these common causes. However, the licensee did not believe that component failure constituted a common cause because the licensee considered the control room emergency ventilation system switch to be due to an original equipment defect, and not to degradation over time. Although the part may have been defective since initial construction, inspectors noted that the part had successfully operated for over 20 years until it first failed in December 1999 and that the root cause evaluation indicated that the part had degraded over time. The inspectors determined that component replacement or preventive maintenance practices were not explored or addressed by the overall root cause evaluation. In the individual root cause evaluations for these events, the licensee documented that no preventive maintenance program existed to replace the individual component on a regular basis.

The licensee also performed a human performance root cause evaluation for reasons apart from this inspection. The inspectors determined that the only safety system functional failure issue addressed in the human performance root cause was the incomplete maintenance in February 2000. The September 1999 control room emergency ventilation system event was not discussed. Additionally, the February 2000 high pressure coolant injection venting issue was not included. The licensee had not included these issues in the overall evaluation of human performance to determine if the corrective actions to the human performance root cause would also prevent the recurrence of these failures.

The licensee's overall root cause evaluation combined the inadequate troubleshooting, the inadequate procedures, and the September 1999 control room emergency ventilation system human performance issues into one causal factor which was categorized as "knowledge deficits in both technical understanding of system behavior and understanding of administrative processes."

The licensee identified two other causal factors which were process focused: weak engineering department response to the multiple safety system functional failures, and focus on a single system rather than a collective function. Finally, the licensee identified a causal factor that specifically applied to the performance indicator, in that they determined that they had not adequately integrated NRC's performance indicator and cornerstone structure into the station processes. The inspectors acknowledged that tracking and integrating performance indicator data was valuable. However the causal factor appeared to be too narrowly focused on the performance of the indicator rather than on performance of all safety systems that may or may not be tracked by the indicator. Other risk significant systems not specifically tracked by a performance indicator were not addressed by this causal factor.

c. *Determine that the root cause evaluation included a consideration of prior occurrences of the problem and knowledge of prior operating experience.*

c.1. YELLOW The knowledge of prior operating experience was addressed in the root cause evaluation. In May 1999, high pressure coolant injection operating experience items for Quad Cities and Dresden stations were reviewed as a plant-wide corrective action based on a previous reactor trip. Over 600 high pressure coolant injection items were reviewed as part of this effort to determine if they impacted the system. The actions taken as a result of the operationing experience were reviewed and judged as to whether the actions were sufficient. The high pressure coolant injection auxiliary oil pump issues were identified three times in the operations experience review, but no licensee investigation was conducted specific to these issues at the time of the review. Additionally, the operationing experience evaluation did not look for potential design problems that had not been appropriately addressed. The licensee wrote Problem Identification Form 2000-2518 to address this issue, but the corrective actions involved had not been implemented at the end of the inspection.

The inspectors found that previous similar occurrences in 1987 and 1996 provided opportunities and recommendations for corrective actions which might have prevented the March 2000 event. This was not identified in the root cause report provided to the inspectors on August 14, 2000, although the events were listed in the report. In addition, the root cause for the March 2000 event did not include corrective actions to address why the recommended corrective actions in the past were not implemented.

c.2 WHITE For each of the events, the licensee reviewed plant history and industry operating experience. Two of the events were repeat failures, and this was considered in the root cause evaluations. The inspectors did not identify any prior occurrences or prior operating experience that the licensee had failed to incorporate.

The overall root cause evaluation included a review of the corrective action database for entries related to "performance indicators" and determined that none involved a NRC performance indicator being challenged due to ineffective implementation of the corrective action program, a narrow system focus, or the failure to modify existing programs to address the new NRC inspection program. The inspectors determined that this search focused on the performance indicator, a tracking mechanism which had been in place for only slightly over a year at the Quad Cities Nuclear Plant, and not on the underlying issue of safety system functional failures. The inspectors determined that, due to the criteria used to define whether there were pertinent previous events, the licensee eliminated a number of previous safety system functional failures which occurred in 1997 and 1998. These events were documented in NRC Inspection Reports 50-254/99011; 50-265/99011 and 50-254/99020; 50-265/99020. Four of these events were on the two systems that contributed to the majority of the 1999 and 2000 events.

d. *Determine that the root cause evaluation included consideration of potential common cause and extent of condition of the problem.*

d.1. YELLOW The inspectors verified that the licensee appropriately considered the potential for common cause for the high pressure coolant injection auxiliary oil pump event, and conducted a thorough extent of condition specific to the root cause of the event. The high pressure coolant injection extent of condition encompassed a review of 127 control instruments for vulnerability of overlap between their setpoints.

Additionally, the extent of condition review included:

3. performance history of instruments and controls and
4. calibration and preventive maintenance history review for potential to either erode existing margin, or to adjust PM frequency to better assure operability.

d.2. WHITE The inspectors verified that the licensee considered the potential for common causes among the events, primarily by completion of the overall root cause report. Each individual root cause evaluation performed an extent of condition review for that event and identified other equipment which could be affected by the failure. Human error and process similarities were not reviewed for extent of condition.

The licensee also performed an extent of condition review for the overall root cause. The extent of condition for the overall root cause took credit for the extent of conditions in each of the individual root causes and primarily looked at the possibility that other NRC performance indicators could be exceeded. The extent of condition reviews generally did not identify where the same type failure could occur. The extent of condition reviews failed to evaluate the common issues (see 02.02b.2) which linked the separate events.

02.03 *Corrective Actions*

a. *Determine that appropriate corrective actions are specified for each root [and/or] contributing cause or that there is an evaluation that no actions are necessary.*

a.1 YELLOW The licensee specified appropriate corrective actions for the root cause and contributing causes. However, two additional contributing causes were identified by the inspectors that were not addressed in the root cause evaluation:

1. Previous corrective actions were ineffective. In 1987 a similar event occurred at Dresden in which the high pressure coolant injection auxiliary oil pump tripped three times during testing. An investigation was performed, and a recommendation was made for extended vendor testing of the system to obtain a better understanding of system performance. This corrective action was never implemented.

   In 1996 a second event occurred at Quad Cities involving the high pressure coolant injection auxiliary oil pump. A problem identification form and licensee event report were written to document the event, but no formal root cause evaluation was conducted because the problem identification form was classified as a Significance Level 3 (the lowest level of classification for problem identification forms). Also, the 1996 investigation did not thoroughly evaluate the previous 1987 event for potential contributing causes.

2. Previous assessments on the high pressure coolant injection system design problems were incomplete. The assessments did not thoroughly address the

impact of issues identified in system reviews, and potential design problems were not addressed. This item was addressed in response to Problem Identification Form Q2000-02518. Planned corrective action was not well formulated at the end of the inspection, but included determining a schedule for self-assessments in Business Plans for 2001 through 2003.

Both of these contributing causes involved previous assessments and did not negate the licensee's actions for the current issue. The completeness of subsequent licensee root cause evaluations will be examined in the 2001 problem identification and resolution inspection.

a.2 WHITE Corrective actions were specified for each root cause and contributing cause specified in each of the individual root cause reports. The corrective actions were specific to the individual event or component, and appeared adequate to prevent that particular failure from recurring. One concern involved the December 1999 and May 2000 control room emergency ventilation system switch cam follower failures. For these events, the corrective actions were to inspect the cam followers in 20 other switches. The corrective actions did not discuss actions to be taken if those cam followers were found to be defective, either in terms of replacement of the devices or in terms of expanding the sample size. This was corrected following discussions with the licensee.

For the overall White PI root cause evaluation, the licensee identified eight corrective actions to prevent recurrence. The licensee considered that the first three actions would prevent recurrence of the first causal factor of "knowledge deficits in both technical understanding of system behavior and understanding of administrative processes. "This causal factor encompassed common causes such as inadequate troubleshooting, inadequate procedures, and inadequate knowledge of a complex system. However, the three corrective actions were to require strengthening of troubleshooting procedures in the maintenance and engineering departments. The corrective actions did not address the role that operators played in troubleshooting – that of recognizing when troubleshooting was required and isolating the equipment so that troubleshooting could occur. This was corrected by the licensee following discussions with the inspectors. The corrective action plans for deficient troubleshooting were not clear in how the implementation would be different than what was in place before these events. A troubleshooting standard and a root cause method were in place previously. Additional efforts to require more troubleshooting when a safety system failure was involved were not clear because safety system failures were not determined immediately, and troubleshooting efforts generally started soon after discovery of a problem. Inspectors also found that in some cases work planners canceled work before a troubleshooting procedure could be entered.

The licensee identified three corrective actions to prevent recurrence of the "system versus function" focus, which was the second causal factor identified in the overall root cause evaluation. The first action was to require immediate performance of a root cause report for any event resulting in a safety system functional failure. The second required that, if a performance indicator was threatened, the root cause report had to address the cumulative effects of that system on the performance indicator. The third corrective action was to proceduralize the second corrective action. It was not clear to the inspectors how the corrective actions would provide a "function versus system" focus.

b. *Determine that the corrective actions have been prioritized with consideration of the risk significance and regulatory compliance.*

b.1. YELLOW The licensee prioritized the corrective actions appropriately, in accordance with their risk significance. At the time of the inspection numerous corrective actions had been completed on Unit 1, and Unit 2 actions were scheduled for October 2000.

b.2. WHITE The licensee appeared to prioritize the corrective actions appropriately, in accordance with risk significance in that actions to restore compliance were taken within an appropriate time frame. Several corrective actions were focused on long term monitoring and plans to set new standards. However, the implementation of these actions to correct the problems were not available at the end of the period.

c. *Determine that a schedule has been established for implementing and completing the corrective actions.*

c.1 YELLOW A schedule was established for all corrective actions. This schedule was reviewed and approved by licensee management.

c.2 WHITE For all the corrective actions, a schedule was established. Licensee management reviewed and accepted the schedule for the corrective actions as part of the approval of the root cause report.

d. *Determine that quantitative or qualitative measures of success have been developed for determining the effectiveness of the corrective actions to prevent recurrence.*

d.1 YELLOW Action Tracking Item AT25768 was established for performance of an effectiveness review of the corrective actions to prevent recurrence. No quantitative or qualitative measures of success had yet been identified specific to this action.

d.2 WHITE All the root cause evaluations, for both the individual event and the overall issue, included a requirement to perform an effectiveness review and established a date to complete that review. Only the corrective actions for the high pressure coolant injection September and October 1999 failures had measures of success established in the root cause evaluation. The inspectors determined that the licensee's processes would allow measures of success to be established outside of the root cause process.

02.04 *Independent Assessment of Extent of Condition and Generic Implications*

a.1 Inspection Scope

This section (02.04) of the report only applies to Inspection Procedure 95002 and the YELLOW performance indicator resulting from the Unit 1 failure of the high pressure coolant injection auxiliary oil pump. This section documents the results of the inspectors review of the licensee’s self-assessment in the area of extent of condition.

Based on a potential generic concern with overlap of instrument and/or component setpoints, the licensee performed self-assessments on other mitigating systems within the affected cornerstone. The self-assessments addressed potential impact of the high pressure coolant injection root cause (causal factors) to these mitigating systems by reviewing issues such as instrumentation and/or component overlap concerns, assessing the potential for system fault exposure due to surveillance or preventive maintenance activities, and reviewing instrumentation for chronic out-of-tolerance issues. In addition, system material condition was assessed by reviewing previous system problems to determine if adequate actions had been taken or were scheduled to resolve the issue, identifying preventive maintenance activities that had not been performed, and reviewing outstanding system modification and design issues.

The inspectors independently assessed the validity of the licensee's conclusions by reviewing a sample of the licensee's self-assessment. The systems reviewed included the emergency diesel generators, standby liquid control, safe shutdown makeup, residual heat removal, high pressure coolant injection, automatic depressurization, and reactor core isolation cooling, along with portions of the remaining systems' self-assessments. As part of the review, the inspectors interviewed the respective system engineers and performed limited walkdowns of selected systems.

b. Findings

Overall, the inspectors determined that the licensee's extent of condition review was acceptable. The scope of the systems reviewed and the extent of those reviews with respect to the causes of the high pressure coolant injection issue were, in most cases, thorough. The results of the licensee's extent of condition review identified several additional issues with the high pressure coolant injection system, but did not identify any significant issues with the other mitigating systems. The self-assessments provided the system engineers with a good historical perspective of system condition. However, the inspectors found some incomplete areas in the extent of condition reviews:

1. Three findings by NRC inspectors from the end of June through the 15th of August indicated that extent of condition reviews by the licensee missed some important material condition problems with high pressure coolant injection. Inspectors found high pressure coolant injection motor speed changer design deficiencies which had been identified in 1996 but never corrected. In addition, inspectors identified a problem with the design for high pressure coolant injection level control which was identified in 1998, but never corrected. Both of these issues were found by inspectors in late June, when the licensee assessment was nearly complete. These issues were documented in Inspection Report 50-254/200007; 50-265/200007. After the licensee self assessment was complete, inspectors also found a design problem with the seal-in logic for high pressure coolant injection initiation which did not meet criteria referenced in the updated final safety analysis. This issue had been identified in 1997 by the licensee. The logic had not been installed, but the corrective action item for tracking it had been closed. The failure to implement corrective actions for this condition was a violation of 10 CFR 50, Appendix B, Criterion XVI "Corrective Action". This violation is being treated as a **Non-Cited Violation (50-254/2000013-01; 50-265/2000013-01)**, consistent with Section VI.A.1 of the

May 1, 2000, Enforcement Policy. This violation was captured in the licensee's corrective action program on Condition Report Q2000-02954. Risk for this design failure was evaluated to be very low (GREEN) because automatic and manual initiation was still possible for the system.

2. Inspectors found that some instruments and system components were not considered to have a potential for setpoint interaction and therefore not evaluated for operating margin. Similar components to the pressure regulating valve involved with the high pressure coolant injection failure, such as a regulating valve on the emergency diesel generator air start system, were not considered. Engineers also intentionally did not evaluate instruments and/or components in some of the emergency diesel generator support systems such as starting air, fuel oil, or cooling water. The licensee explained that if the component did not have a condition report written on it in the past and/or the unavailability for the NRC performance indicator caused by failure of the component would be less than 3 months, it was not included in the extent of condition review.

3. A condition was identified that could potentially cause a failure of the reactor core isolation cooling system to perform its function on demand. Review of data from 18-month surveillance test QCOS 1300-23 indicated that time delay relay TDR 13A-K21 was left at the low end of its specified range.

   The reactor core isolation cooling system was designed to isolate if a high steam flow condition (which might be caused by a steam line break) was sensed. During system start however, high steam flow conditions exist. Time delay relay, TDR 13A-K21 was intended to actuate during system start to prevent system trip on high in-rush steam flow and to re-enable the protection 3 to 9 seconds later in the event of a steam line break.

   The "as left" condition of the relay was 3.02 seconds. There were no administrative limits to prevent going below the Technical Specification setting of 3 seconds. The system engineer had identified this as a condition warranting corrective action and Work Request 990146571 was submitted to adjust the relay to the middle of the six-second band. This work request was canceled prior to work being performed because the relay had a history of good repeatability and was difficult to reset. During the system engineer's extent of condition review, an assessment was made that due to the expected repeatability of this relay, an additional 18-month cycle could pass without the relay going out of tolerance.

   The system engineer wrote another condition report, CR Q2000-02832 to address why the earlier work request was canceled with inadequate communication. Work Request 990200438 was subsequently generated to reset the relay towards the middle of the band. The request was given a low priority and scheduled for August 13, 2001.

   According to the data presented to the inspectors, only two of three data points used in the engineer's review supported repeatability of the relay set point. The inspectors discovered that the licensee had recently performed updated instrument drift calculations for this type of relay to determine the tolerance band needed to support 24-month test intervals. The calculations determined that this type of time delay relay had a drift potential that could have caused the relay to go below the Technical Specification setting well before the scheduled date of the work request. After discussions with the inspectors, the licensee changed the priority to reset the relay. At the end of the inspection, the relay was found to be just within the Technical Specification requirements, and was reset to the middle of the band.

In the extent-of-condition assessment for reactor core isolation cooling system vulnerabilities, the licensee had concluded that there was no reliability issue because the high steam flow isolation had proven functional. This assessment would have been correct for just the isolation, but not for the system reliability. The inspectors concluded that, in this example, the licensee had not adequately considered the potential adverse effect of a relay setpoint on system reliability.

Following a technical debrief at the end of the onsite inspection period, the licensee revised several of the evaluations to address the inspector's concerns. The licensee's extent of condition review was determined to be acceptable and subsequent extent of condition reviews will be examined in the 2001 Problem Identification and Resolution Inspection.

4OA3 Event Follow-up

a. Inspection Scope

The inspectors reviewed licensee event reports related to the safety system functional failures.

b. Findings

(Closed) Licensee Event Report 50-254/00004-00: Failure of Control Room Emergency Ventilation Refrigeration Control Unit. This event was a repeat of the December 1999 event. Upon the repeat failure, the licensee performed further trouble-shooting and determined that the cam follower for the switch was defective. Based on the information available, the license determined that the cam follower probably was defective when installed; however, the root cause report did note that a rectangular hole in the cam follower had become rounded out over time. The licensee replaced the cam follower and planned on inspecting a random sample of other similar control switches. The root cause for this event was evaluated as part of the overall Unit 1 safety system functional failures, as the event applies to both units. Since this is a repeat of the December 1999 failure, the risk evaluation done in Inspection Report 50-254/99025; 50-265/99025 applies also to this event. This Licensee Event Report is closed.

(Closed) Licensee Event Report 50-265/99003-00: Reactor Core Isolation Cooling Overspeed Trip Due to Failed Governor Control Power Resistor. This event was discussed in detail in Inspection Reports 50-254/99018; 50-265/99018, 50-254/99020;

50-265/99020 and 50-254/2000003; 50-265/200003. This licensee event report is closed.

40A4 Management Meetings

.1 Exit Meeting Summary

The inspectors presented the inspection results to members of licensee management at the conclusion of the inspection on September 15, 2000. The licensee acknowledged the findings presented. Although the licensee did not entirely agree with all of the weaknesses identified by the inspectors, nevertheless, the licensee revised several of the root cause evaluations to ensure appropriate actions were developed to address the inspector's concerns. No proprietary information was identified. Licensee exit presentation slides used during the meeting are attached as Enclosure 2.

.2 Public Meeting Summary

The NRC held a public meeting with the licensee on July 14, 2000. The NRC discussed the revised oversight program, the results of the NRC's inspections, and related issues. The licensee outlined the events, root causes and causal factors, the organizational and hardware aspects of the failures and resultant WHITE and YELLOW performance indicators, and the completed and proposed corrective actions.

LIST OF DOCUMENTS REVIEWED

The following is a list of licensee documents reviewed during the inspection, including documents prepared by others for the licensee. Inclusion on this list does not imply that NRC inspectors reviewed the documents in their entirety, but, rather that selected sections or portions of the documents were evaluated as part of the overall inspection effort.

Self-Assessment Plan Degraded Mitigating Cornerstone, Revision 5, August 8, 2000

Focus Area Self-Assessment Report Degraded Mitigating Systems Cornerstone, Revision 3, August 12, 2000

Mitigating Cornerstone System Self-Assessments:

Emergency Diesel Generator System
Standby Liquid Control System
Safe Shutdown Makeup Pump System
Residual Heat Removal System
High Pressure Coolant Injection System
Reactor Core Isolation Cooling System
Automatic Depressurization System
Standby Gas Treatment System
Control Room Emergency Ventilation System
Core Spray System

<u>Root Cause Reports</u>

AT15869	High Pressure Coolant Injection Subsystem Steam Supply Isolation 1-2302-5 Valve Failure to Close Due to Electrical Contactor Binding Caused by an Inadequate Preventive Maintenance Procedure, Revision 0 (Problem Identification Forms (PIFs) Q1999-03343 and Q1999-02935) LER 99-003
AT16131	Control Room Emergency Ventilation System Air Filtration Unit Exceeded Technical Specification Air Flow Rate Limits Due to an Inadequate Procedure Instruction and Inadequate Understanding of System Behavior, Revision 2 (PIF Q1999-02987) LER 99-004
AT18814	High Pressure Coolant Injection Subsystem Inoperable Due to Steam Exhaust Vacuum Breaker 2-2399-65 Failure to Close During QCOS 2300-18 Potentially Caused by Foreign Material, Revision 2 (PIF Q1999-03773)
AT19005	Reactor Core Isolation Cooling Overspeed Due to Failed Governor Control Power Supply Resistor, Revision 0 (PIF Q1999-03858)
AT20686	Failure of the Control Room Emergency Ventilation System B Train Local Control Switch Due to Defective Parts and Inadequate Knowledge of the

Complex System Resulting in a Refrigeration Condensing Unit Trip, Revision 2 (PIF Q2000-01891)

AT22303	Safe Shutdown Makeup Pump 2-2901-8 Valve Inoperable Due to Failure to Stake the Yoke Bushing to Vendor Requirements, Revision 0
AT25768	Unit 1 High Pressure Coolant Injection Subsystem Auxiliary Oil Pump Failure to Continue Running on an Auto-initiation Signal During High Pressure Coolant Injection Logic Functional Test Caused by Inadequate Design Margin on the Control Oil System, Revision 1 (PIF Q2000-01214)
AT23538	High Pressure Coolant Injection Failure to Start Due to Improper Work Package Closure for Interlock Dump Valve, Revision 3
AT24034	High Pressure Coolant Injection Discharge Piping Failure to Vent During QCOS 2300-09 (High Pressure Coolant Injection Monthly Vent Verification) Due to Inadequate Fill and Vent Because of an Inadequate Procedure, Revision 0
AT31772	Safety System Functional Failures Exceeded Performance Indicator White Threshold Due to Inadequate Knowledge of Complex Systems, a System Vice Functional Focus and Inadequate Integration of the New NRC Inspection Program into the Station's Processes (Condition Report Q2000-02510)
AT31648	Unacceptable Number of Recent Consequential Human Performance Errors Due to Inadequate Implementation of the Human Performance Initiative in 1999 and Inadequate Root Cause Investigations

<u>Condition Reports (Problem Identification Forms) Reviewed During the Inspection</u>

Q1998-04405	QCTS 0300-01 Caused all Low Pressure ECCS to be Inoperable
Q1998-04822	Switch Out-of-Tolerance While Performing QCIS 1000-11
Q1998-04840	Shutdown Cooling Suction Valves Closed When MO-1-1001-50 Opened
Q1999-00033	Switch Out-of-Tolerance While Performing WR 970128104-01
Q1999-00217	LPCI Mode of RHR Inoperable Due to Failed DPIS to LPCI Loop Select
Q1999-01219	Trip Point Out-of-Tolerance
Q1999-01711	Switches Out-of-Tolerance While Performing QCIS 1000-11
Q1999-02873	Feedwater is Leaking into the SSMP Discharge Header Causing High Pressure
Q1999-02878	Delay in Restoring SSMP Availability
Q1999-04069	SSMP Rotating Element Material Condition Degraded
Q2000-00241	Broken Stem Nut on 2-2901-8
Q2000-00244	Safe Shutdown Makeup Pump Inoperable due to MO 2-2901-8; LCO Entered
Q2000-00405	Diesel Generator Starting Air Compressor Pressure Switch OOT
Q2000-00870	'A' Loop RHR and Recirc Line Break Logic DPIS
Q2000-01434	U-2 Diesel Generator Trip & Alarm Switches Calibration/Function
Q2000-02081	Switch OOT
Q2000-02848	Unit 2 SBLC Motor Vibration

Q2000-02510	Performance Indicator on Safety System Functional Failures Turns White Due to Licensee Event Report 1-00-004, June 16, 2000
Q2000-02518	Potential That Previous Assessments on System Material Condition Were Shallowly Focused, July 11, 2000
Q2000-02993	Root Cause Report for the Safety System Functional Failure White Window Contains Some Apparent Minor Discrepancies, August 14, 2000

Licensee Event Reports

254/99-03	High Pressure Coolant Injection Inoperable Due to Manual Closure of a High Pressure Coolant Injection Steam Supply Isolation Valve, Revisions 0 and 1 (applies to both units)
254/99-04	Control Room Emergency Ventilation System Air Filtration Unit Inoperable Due to Airflow Rate in Excess of Technical Specifications Allowable, Revisions 0 and 1 (applies to both units)
254/99-05	B Control Room HVAC Inoperable Due to Refrigeration Control Unit Breaker Trip, Revision 0 (applies to both units)
254/00-01	Safe Shutdown Makeup Pump Injection Valve Inoperable, Revision 0 (applies to both units)
254/00-03	High Pressure Coolant Injection Auxiliary Oil Pump Failure to Continue Running, Revisions 0 and 1
254/00-04	Failure of Control Room Emergency Ventilation Refrigeration Control Unit, Revision 0 (applies to both units)
265/99-03	Reactor Core Isolation Cooling Overspeed Trip Due to Failed Governor Control Power Resistor, Revision 0
265/99-04	High Pressure Coolant Injection Steam Exhaust Vacuum Breaker Failure to Close During Surveillance, Revision 0
265/00-05	High Pressure Coolant Injection Inoperability During Low Pressure Testing Due to Incomplete Maintenance Activities and Inadequate Venting, Rev. 0 and 1

Procedures

CAP-3	Root Cause Investigation and Report Handbook, Revisions 1, 2 and 3
NSP-AP-4004	Corrective Action Program Procedure, Revision 4
QCOS 2300-4	High Pressure Coolant Injection Steam Line High Flow Analog Trip System Calibration and Functional Test, Revision 11
QCOS 2300-06	Quarterly High Pressure Coolant Injection System Power Operated Valve Test, Revision 18
ER-AA-520	Instrument Performance Trending, Revision 0
QCERM-0400-02	Inspection, Repair, and Maintenance of DC Operated Cutler-Hammer Motor Controller, Revision 19

Surveillance

QCOS 2300-06	Quarterly High Pressure Coolant Injection System Power Operated Valve Test, Revision 15, completed September 11, 1999

Work Requests

970029449	Spurious Alarm on Air Handling Unit Train "B" Inlet Temperature High, September 1, 1999
990092215	Valve Failed to Close from Control Switch at 901-3 Panel, September 7, 1999

Calculations

QDC-4600-I-0242	Diesel Generator Starting Air Compressor Pressure Switch Setpoint Error Analysis, Revision 2

Miscellaneous

Maintenance Rule (a)(1) Action Plan for the High Pressure Coolant Injection System

Equipment/Component Engineering Data

EPN PI 0-4641-31	Pressure Indicator Diesel Start Air Receiver 1/2A
EPN PI 0-4641-37	Pressure Indicator Diesel Start Air Receiver 1/2D
EPN PS 0-4641-39	Diesel Generator Air Receiver Tank ½-4600 A & B Low
EPN PS 0-4641-41	Diesel Generator Air Receiver Tank ½-4600 C & D Low
EPN PS 0-4641-43A	Diesel Generator Air Compressor ½-4609-A Discharge
EPN PS 0-4641-43B	Diesel Generator Air Compressor ½-4609-B Discharge
EPN 0-4641-44	Diesel Generator ½-6601 Air Start Header
EPN 0-4699-224	Diesel Generator ½ Starting Air Header Pressure Control Valve
EPN 0-4699-306B	Diesel Generator 1/2B Air Receiver Tank Relief Valve

PARTIAL LIST OF PERSONS CONTACTED

Licensee

J Dimmette	Site Vice President
G. Barnes	Station Manager
P. Behrens	Chemistry Manager
J. Benjamin	NGG-Vice President
G. Boerschig	Engineering Director
R. Chrzanowski	Nuclear Oversight Manager
R. Gideon	Work Control Manager
M. McDowell	Operations Manager
M. Perito	Maintenance Manager
J. Skolds	NGG-Chief Operating Officer
F. Tsakeres	Training Manager
D. Tubbs	MidAmerican Energy Representative

NRC

G. Grant	Director, Division of Reactor Projects
M. Ring	Chief, Division of Reactor Projects, Branch 1

IDNS

R. Schulz	Section Chief
C. Settles	Division Chief

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-254/2000013-01	NCV	inadequate corrective action for HPCI design flaw
50-265/2000013-01	NCV	inadequate corrective action for HPCI design flaw

Closed

50-254/00004-00	LER	failure of control room emergency ventilation refrigeration control unit
50-265/99003-00	LER	reactor core isolation cooling overspeed trip due to failed governor control power resistor
50-254/2000013-01	NCV	inadequate corrective action for HPCI design flaw
50-265/2000013-01	NCV	inadequate corrective action for HPCI design flaw

Discussed

None

LIST OF SUPPLEMENTAL INSPECTIONS PERFORMED

The following inspectable-area procedures were used to perform inspections during the report period. Documented findings are contained in the body of the report.

Inspection Procedure	Title
95501	INSPECTION FOR ONE OR TWO WHITE INPUTS IN A STRATEGIC PERFORMANCE AREA
95502	INSPECTION FOR ONE DEGRADED CORNERSTONE OR ANY THREE WHITE INPUTS IN A STRATEGIC PERFORMANCE AREA

LIST OF ACRONYMS AND INITIALISMS USED

AC	Alternating Current
CFR	Code of Federal Regulations
DC	Direct Current
HPCI	High Pressure Coolant Injection
kV	Kilovolt
LER	Licensee Event Report
NCV	Non Cited Violation
PI	Performance Indicator
PIF	Problem Identification Form
QOA	Quad Cities Abnormal Operating Procedure
QCOS	Quad Cities Operating Surveillance
RCIC	Reactor Core Isolation Cooling
RWCU	Reactor Water Cleanup
TMOD	Temporary Modification
URI	Unresolved Item
Vdc	Volts - Direct Current

ComEd
A Unicorn Company

Quad Cities Nuclear Power Station

NRC
Degraded Cornerstone
Exit

September 15, 2000

ComEd
A Unicorn Company

Mitigating Systems Reviews

- ❑ Rigorous process designed to address mitigating systems' performance
  - * Well defined charter
  - * Supported by Quad Cities, other ComEd sites, corporate, and industry personnel
  - * Oversight and challenge by corporate management throughout process

Mitigating Systems Reviews

- ❑ Conducted Root Cause Assessment of HPCI Event

- ❑ Designed Self Assessment to Include all Mitigating Systems
  - * HPCI, RCIC, RHR, EDG, SBLC, ADS, SSMP, CS, CREVS, SBGT

- ❑ Individual SSFF Root Causes
  - * HPCI, RCIC, CREVS, SSMP

- ❑ SSFF Root Cause - Root Cause for White P1
  - * Looked at SSFF root causes and corrective actions

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Mitigating Systems Reviews

❑ Self Assessment Included

- * Review and Evaluation of Chronology of Problems
- * Review of Operating Experience : Quad Cities, Dresden, Industry
- * Assessment of 18 Month/Greater Surveillances
- * Review of Open, Canceled, and Single Unit Modifications
- * Evaluation of Adequacy of Monitoring, Trending, and Analysis
- * Review of Extent of Condition for Identified Problems
- * Screening, Prioritization, and Performance of Design Reviews

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Mitigating Systems Reviews

❑ Subsequent to August 25th Technical Debrief

* Commissioned an independent assessment to determine that the Self Assessment accomplished its intended objectives.

* Created a Summary document "Road - Map" that links root cause reports and assessments, and actions completed and planned.

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Actions Taken Following Technical Debrief

❑ HPCI Root Cause enhanced to address 1987 Dresden Event

* Missed opportunity for previous ineffective corrective actions

- ❑ RCIC Root Cause revised to address why hydraulic effects were not a cause
- ❑ CREVS Root Cause enhanced to provide basis for sample size and expansion criteria if additional failures are identified
- ❑ SSFF Root Cause - reevaluated extent of condition
- ❑ RCIC Time Delay Relay reset closer to mid-range

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Lessons Learned

- ❑ HPCI system had the most significant issues

* Legacy issues not properly addressed.

* Individual performance issues with identifying, communicating, and correcting problems.

* Management oversight was ineffective in correcting individual performance issues and challenging system reliability.

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Lessons Learned

❑ Human Performance significantly contributed to Safety System Functional Failures.

❑ Our management systems and programs were telling us that there was a potential aggregate unavailability problem with the mitigating systems and we were slow to react.

❑ Found that station personnel were not consistently, aggressively pursuing corrective actions.

❑ Mitigating Systems Self Assessment was a useful tool for assessing system health and identifying weaknesses.

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Recent System Improvements

❑ HPCI - Unit One Completed! Unit 2 Scheduled Oct. 2
   * Auto-initiation seal in circuitry installed on low level start
      • New Turning Gear Solenoid Installed

- Corrected Auxiliary Oil Pump design to seal in Auxiliary Oil Pump
- Eliminated auto start of Emergency Oil Pump
- Eliminated Motor Speed Changer cycling

❑ RCIC - Both Units Completed

* Reset Time delay relay to mid-range

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Recent System Improvements

❑ EDGs

* EDG issues Completed on the 1/2 EDG
  * Re-crank modification
  * Bus Auto Transfer Logic Time Delay Relay
  * TD- 1 Time Delay Relays for oil pressure
  * Unit 1 and Unit 2 by the end of October.
* Zinc Anodes on DIG Heat Exchangers

* Unit 2 and Unit 1/2 complete
* Unit 1 scheduled for Q1R16
* Speed sensing updated on 1/2 EDG
* Relocated and replaced TD-2 relay - tech spec relay - 15 sec. timer for starting motor - all diesels

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Acronyms

- HPCI- High Pressure Coolant Injection
- RCIC- Reactor Core Isolation Cooling
- RHR- Residual Heat Removal System
- SBLC- Standby Liquid Control
- ADS- Automatic Depressurization System
- SSMP- Safe Shutdown Makeup Pump
- CS- Core Spray

- CREVS- Control Room Emergency Ventilation System
- SBGT- Standby Gas Treatment
- SSFF- Safety System Functional Failure
- EDG- Emergency Diesel Generator
- P1- Performance Indicator