UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
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February 20, 2009

EA-08-046

Mr. Charles G. Pardee
Senior Vice President, Exelon Generation Company, LLC
President and Chief Nuclear Officer (CNO), Exelon Nuclear
4300 Winfield Road
Warrenville IL 60555

SUBJECT: BYRON STATION, UNITS 1 AND 2, SUPPLEMENTAL INSPECTION REPORT 05000454/2009-006; 05000455/2009-006

Dear Mr. Pardee:

On January 23, 2009, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Byron Station, Units 1 and 2. The enclosed report documents the inspection results, which were discussed during a Regulatory Performance Meeting on January 23, 2009, with Mr. B. Adams and other members of your staff.

As required by the NRC Reactor Oversight Process Action Matrix, this supplemental inspection was performed in accordance with Inspection Procedure 95001, "Inspection for One or Two White Inputs in a Strategic Performance Area." The purpose of the inspection was to examine the causes for, and actions taken related to a finding having low to moderate safety significance (i.e., White) at Byron Station. The finding involved the failure to take timely corrective actions after the identification of extensive corrosion on essential service water system riser pipes and the failure to verify the adequacy of the methodology and design inputs in calculations that supported your staff's decision to accept three degraded essential service water system riser pipes for continued service. This issue was documented previously in NRC Inspection Report 05000454/2007009; 05000455/2007009. The NRC staff was informed in September 2008 of your staff's readiness for this inspection.

This supplemental inspection was conducted to provide assurance that the root causes and contributing causes of the event resulting in the White finding are understood, to independently assess the extent of condition, and to provide assurance that the corrective actions for the risk significant performance issues are sufficient to address the root causes and contributing causes, and to prevent recurrence.

The inspection examined 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. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

The inspectors determined that your root cause evaluation was conducted to a level of detail commensurate with the significance of the problem and reached reasonable conclusions as to the root and contributing causes of the event. The inspectors also concluded that you identified reasonable/appropriate corrective actions for each root and contributing cause and that the corrective actions appeared to be prioritized commensurate with the safety significance of the

issues. However, the inspectors had several observations regarding specific aspects of the root cause evaluation and corrective actions that warranted additional consideration by your staff.

Based on the results of this inspection, no findings of significance were identified.

In accordance with 10 CFR 2.390 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), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA by R. Ng Acting for/

Richard A. Skokowski, Chief
Branch 3
Division of Reactor Projects

Docket Nos. 50-454; 50-455
License Nos. NPF-37; NPF-66

cc w/encl: Site Vice President - Byron Station
Plant Manager - Byron Station
Regulatory Assurance Manager - Byron Station
Chief Operating Officer and Senior Vice President
Senior Vice President - Midwest Operations
Senior Vice President - Operations Support
Vice President - Licensing and Regulatory Affairs
Director - Licensing and Regulatory Affairs
Manager Licensing - Braidwood, Byron, and LaSalle
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Illinois Emergency Management Agency
J. Klinger, State Liaison Officer,
Illinois Emergency Management Agency
P. Schmidt, State Liaison Officer, State of Wisconsin
Chairman, Illinois Commerce Commission
B. Quigley, Byron Station

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Letter to C. Pardee from R. Skokowski dated February 20, 2009

SUBJECT: BYRON STATION, UNITS 1 AND 2, SUPPLEMENTAL INSPECTION REPORT 05000454/2009-006; 05000455/2009-006

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U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos:	50-454; 50-455
License Nos:	NPF-37; NPF-66
Report Nos:	05000454/2009-006 and 05000455/2009-006
Licensee:	Exelon Generation Company, LLC
Facility:	Byron Station, Units 1 and 2
Location:	Byron, Illinois
Dates:	January 20, 2009, through January 23, 2009
Inspectors:	B. Kemker, Senior Resident Inspector J. Jacobson, Senior Reactor Inspector
Approved by:	R. Skokowski, Chief Reactor Projects Branch 3 Division of Reactor Projects

Enclosure

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SUMMARY OF FINDINGS

IR 05000454/2009006; 05000455/2009006; January 20, 2009 – January 23, 2009; Byron Station, Units 1 and 2; Supplemental Inspection – Inspection Procedure (IP) 95001.

This supplemental inspection was performed by a Senior Resident Inspector and Senior Reactor Inspector. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 4, dated December 2006.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Initiating Events

This supplemental inspection was performed in accordance with Inspection Procedure 95001, "Inspection for One or Two White Inputs in a Strategic Performance Area" to assess the licensee's root cause evaluation, extent of condition determination, and corrective actions for the licensee's failure to take timely corrective actions after the identification of extensive corrosion on essential service water system riser piping. This finding was previously characterized as having low to moderate safety significance (i.e., White) in an NRC letter dated April 1, 2008, which finalized the preliminary assessment of the finding documented in NRC Inspection Report 05000454/455/2007009.

During this inspection, the inspectors determined that the licensee's root cause evaluation was conducted to a level of detail commensurate with the significance of the problem and reached reasonable conclusions as to the root and contributing causes of the event. The inspectors also concluded that the licensee identified reasonable/appropriate corrective actions for each root and contributing cause and that the corrective actions appeared to be prioritized commensurate with the safety significance of the issues. The inspectors, however, noted the following observations that warranted additional consideration by the licensee:

- The licensee's root cause evaluation and the safety culture components review had not adequately considered the failure of the licensee's self and independent assessment processes to identify the issues that caused or contributed to the event.
- In one instance, the licensee's root cause evaluation did not adequately determine the applicability of the root causes of an industry event to the Byron event.
- The licensee, in formulating corrective actions, had not evaluated the need for or developed a clear plan to address the possible need to re-inspect piping that was close to but passed wall thickness acceptance criteria.

Given the licensee's acceptable performance in addressing the inoperable essential service water system, the White finding associated with this issue will only be considered in assessing plant performance for a total of five quarters in accordance with the guidance in Inspection Manual Chapter 0305, "Operating Reactor Assessment Program."

Findings

No findings of significance were identified.

B. Licensee-Identified Violations

No findings of significance were identified.

REPORT DETAILS

4. OTHER ACTIVIES

40A4 Supplemental Inspection (95001)

.01 Inspection Scope

This inspection was conducted in accordance with Inspection Procedure (IP) 95001, "Inspection for One or Two White Inputs in a Strategic Performance Area," to assess the licensee's evaluation of one inspection finding of low to moderate safety significance (White) in the Initiating Events Cornerstone. The inspection objectives were to:

- Provide assurance that the root causes and contributing causes of risk significant performance issues are understood;
- Provide assurance that the extent of condition and extent of cause of risk significant issues are identified; and
- Provide assurance that licensee corrective actions to risk significant performance issues are sufficient to address the root causes and contributing causes, and to prevent recurrence.

In a letter dated April 1, 2008, the NRC communicated the final significance determination for a finding having low to moderate safety significance (i.e., White), with two associated violations of NRC requirements, at Byron Station. The finding involved the failure to take timely corrective actions after the identification of extensive corrosion on essential service water (SX) system riser pipes and the failure to verify the adequacy of the methodology and design inputs in calculations that supported the licensee's decision to accept three degraded SX system riser pipes for continued service. The NRC reviewed the circumstances that led to the finding and the licensee's initial root cause evaluation activities during a Special Inspection completed on February 14, 2008. The details of the performance issues and the preliminary results of the NRC's significance evaluation were documented in NRC Inspection Report 05000454/455/2007009. Byron Station, Units 1 and 2, entered the Regulatory Response column of the NRC's Action Matrix in the first quarter of 2008 based on the White inspection finding. In September 2008, the licensee notified the NRC that applicable corrective actions for the finding had either been completed or initiated, and that it was ready for the NRC to conduct this supplemental inspection to review its evaluation of the causes and the actions taken to address the White finding.

The inspectors reviewed the licensee's root cause evaluation in addition to other evaluations conducted in support and as a result of the root cause evaluation. The inspectors reviewed corrective actions that were taken or planned to address the identified causes. The inspectors also held discussions with licensee personnel to ensure that the root and contributing causes and the contribution of safety culture components were understood and corrective actions taken or planned were appropriate to address the causes and preclude repetition.

.02 Evaluation of the Inspection Requirements

02.01 Problem Identification

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

The inspectors determined that the licensee's root cause evaluation adequately described the conditions of this self-revealing event.

On October 19, 2007, during rust removal from the 0C SX riser pipe upstream of valve 0SX163C (between the concrete floor and the valve), in preparation for pipe wall thickness measurements, a ½ inch diameter 10 gallon-per-minute leak occurred. At the time of the event, the licensee was in the process of determining the extent of pipe wall thinning because substantial corrosion was present that put into question the future operability of the system. Because this section of pipe could not be isolated from other cells on the 0A SX cooling tower basin, the licensee declared the 0A SX tower of the ultimate heat sink inoperable, and shut down both units due to entry into Technical Specification 3.7.9 (reference Licensee Event Report (LER) 2007-002-00). The riser pipe leak was caused by a loss of pipe wall thickness due to external corrosion induced by the wet environment within the vault enclosure surrounding the unprotected carbon steel pipe upstream of the isolation valve. The licensee had failed to preserve and protect the pipe external surface from the corrosive environment in the vault, which eventually allowed corrosion to deteriorate the pipe wall until it leaked through. The corrosion processes that caused this leak affected all eight SX riser pipes at the same location and had occurred over many years.

On December 12, 2007, the licensee completed a root cause evaluation to investigate the organizational and programmatic issues that led to the through wall leak on the OC SX riser pipe.

b. Determine whether the evaluation documented how long the issue existed, and whether there were any prior opportunities for identification.

The inspectors determined that the licensee's root cause evaluation identified how long the issue had existed and adequately examined prior opportunities for identification.

The root cause evaluation concluded that the corrosion problems had existed for many years and grew worse over time until the leak was found on the 0C SX riser pipe in October 2007. There had been multiple opportunities for the licensee to identify and correct the degraded conditions before the event. The licensee began documenting the presence of corrosion on SX riser piping upstream of the riser isolation valves in August 2006. Multiple examples were discussed in the root cause evaluation, including the 0G riser in August 2006, 0D riser in October 2006, 0B riser in November 2006, 0C riser in March 2007, and 0A riser in May 2007. A common approach to address identified corrosion problems on these risers was evident in the root cause evaluation. Issue reports were written to document the deficiencies. The issue reports were closed to work requests to clean and coat the associated piping. The work requests were then rolled to work orders that were given a "C" priority and designated as elective maintenance. The piping was deemed operable based on the SX riser vaults being "out of service at the time for inspections and repairs and that all open issues will be properly

dispositioned prior to returning the cell to service." No evaluation of the degraded conditions was requested by Operations or prepared by Engineering that addressed the deficiencies with respect to operability of the safety-related riser piping. No additional inspection methodologies or increased frequencies resulted from the issue report evaluations.

As discussed in Section 4OA3.3 of NRC Inspection Report 05000454/455/2007009, the NRC concluded that the licensee had missed several earlier opportunities to detect and prevent SX riser pipe corrosion. These early opportunities were also discussed in the root cause evaluation. Examples of these missed opportunities included: (1) a 1993 SX Riser Valve Task Force established to evaluate pipe conditions for the SX basins and repair options that initiated work requests to clean and recoat the SX riser pipe between the concrete floor and flange to protect these pipes from further corrosion; (2) cancellation of the above work requests in 1995 based on the mistaken belief that this section of pipe would be replaced during future modifications; (3) implementation of a 1997 SX system modification that replaced the carbon steel SX piping downstream of the riser isolation valves, but did not include replacement of the upstream section of piping and did not refurbish the protective coating; (4) a 1990 licensee internal memorandum and contractor report identified that substantive corrosion was present on the SX cooling tower carbon steel distribution piping; and, (5) three or more visual inspections for each of the degraded riser pipes from 1997 through 2004 in which the licensee's staff directly observed the riser pipe surfaces to look for evidence of leakage that did not document any evidence of external corrosion.

c. *Determine whether the licensee's root cause evaluation documented the plant specific risk consequences and compliance concerns associated with the issue.*

The inspectors determined that the licensee adequately documented the plant specific risk consequences and compliance concerns associated with the issue.

The licensee completed a Phase 3 significance determination process (SDP) assessment and documented it in BB PRA-017.75B, "Byron Essential Service Water (SX) Cooling Tower Riser Pipe Degradation Phase 3 Significance Determination Process (SDP) Assessment." The licensee concluded that by considering internal events only, the result would be a change in core damage frequency of less than 1E-6 per year, which would result in a Green condition (i.e., very low safety significance) under the SDP. When considering external events, the licensee concluded that the only challenge to riser integrity was beyond design basis seismic events; while the NRC concluded that an increase in the pipe rupture likelihood had occurred overall. The licensee used engineering judgment to assign probabilities of large pipe failure for varying levels of seismic hazards. Using this approach, a change in core damage frequency on the order of 3E-6 per year was estimated, which would result in no greater than a White condition (i.e., low to moderate safety significance) under the SDP. As discussed in Section 4OA3.8 of NRC Inspection Report 05000454/455/2007009, the NRC's conclusion and the licensee's conclusion regarding the risk significance were in agreement.

In a letter dated May 1, 2008, the licensee acknowledged the compliance concerns identified by the NRC and discussed the reason for the violations and corrective actions taken for the event.

d. Findings

No findings of significance were identified.

02.02 Root Cause, Extent of Condition, and Extent of Cause Evaluation

a. *Determine whether the licensee's root cause evaluation applied systematic methods in evaluating the issue in order to identify root causes and contributing causes.*

The inspector determined that the root cause evaluation adequately applied systematic methods in evaluating the issue in order to identify root causes and contributing causes.

In its root cause analysis, the licensee used appropriate systematic processes and methods including failure modes and effects, use of an event and causal factor chart, and TapRooT® to identify root causes and contributing causes for the event.

b. Determine whether the licensee's root cause evaluation was conducted to a level of detail commensurate with the significance of the problem.

The inspectors determined that the root cause evaluation was conducted to a level of detail commensurate with the significance of the problem and reached reasonable conclusions as to the root and contributing causes of the event.

Following the October 19, 2007, event, the licensee initiated a root cause evaluation to investigate the organizational and programmatic issues that led to the through wall leak on the 0C SX riser pipe upstream of valve 0SX163C. The NRC previously reviewed the licensee's root cause evaluation team charter, quarantine of materials, vendor materials testing, and technical root cause evaluation activities in detail during a Special Inspection completed on February 14, 2008. The inspectors concluded in NRC Inspection Report 05000454/455/2007-009 that the licensee's controls established for quarantining materials and components to preserve the as-found conditions for laboratory testing and/or analysis were sufficient to provide accurate and timely feedback for determination of the root cause. The inspectors also concluded that the licensee's preliminary physical causes were consistent with the observed condition of the 0C SX riser with consideration for materials, operating history, and environment.

The licensee identified three root causes in the evaluation:

- A technical root cause was identified as general and pitting corrosion caused by long-term exposure of the non-protected carbon steel pipe to the misting air/water cooling tower environment.
- A programmatic root cause was identified that there were less than adequate procedure guidance related to trending, tracking, identification threshold, and follow-up action determination related to safety related external pipe corrosion.
- An organizational issue was identified where over reliance of informal mechanisms was used to asses equipment operability. The root cause of this issue was that management failed to identify weaknesses that led to ineffective decision-making affecting issue prioritization and driving timely completion of corrective actions. These weaknesses existed within non-destructive evaluation, design assumptions, Operations, Engineering, Work Control, corrective action program, and the Plant Health Committee.

The licensee identified twelve contributing causes in the evaluation:

- Weaknesses in procedure guidance for documentation requirements related to operability.
- Lack of Operations ownership to require formal documentation for safety-related operability concerns.
- Less than adequate management reinforcement of the operability determination in operator logs.
- Inadequate procedure guidance in ER-AA-2030, “Conduct of Plant Engineering Manual,” regarding margin management.
- Ineffective management oversight related to tracking, trending, and communication of remaining margin to decision making bodies.
- Less than adequate training on implementation of CC-AA-13, “Margin Management,” and ER-AA-2007, “Evaluating Margins.”
- Weaknesses in procedure guidance on issue report and work request prioritization related to non-conformance of safety systems.
- Engineering failed to accurately characterize the level of degradation due to unfounded assumptions of the SX corrosion rate, non-destructive examination data, and discrete elements used in calculating operable but degraded pipe conditions.
- Inadequate preventative maintenance program for safety-related piping.
- Less than adequate corporate oversight, within the Operations and Engineering areas for Byron’s continuing SX issues relating to system health, operability, and repair work prioritization.
- Inadequate engineering standards use and adherence
- Less than adequate training on log entry requirements for component/system operability.

The licensee’s root cause evaluation team performed an aggregate review of the causes identified using TapRooT® and associated topical areas to determine potential generic causes. This resulted in the identification of three areas: (1) ineffective use of learning programs, (2) over reliance between organizations, and (3) engineering practices. Cause and effect analysis was then used to arrive at generic causes. The results of this analysis identified the following generic causes:

<u>Ineffective Use Of Learning Programs</u>

- There was less than adequate guidance in conducting reviews of operating experience. This was not identified as a contributing cause, but was related to the programmatic aspects discussed below.
- There were weaknesses in procedure guidance on issue report and work request prioritization related to non-conformance of safety systems.

<u>Over Reliance Between Organizations</u>

- Management failed to identify weaknesses that led to ineffective decision-making affecting issue prioritization and driving timely completion of corrective actions.
- There was over reliance on informal mechanisms to declare equipment operability.
    - Weaknesses in procedure guidance for documentation requirements related to operability.

    - Less than adequate training on implementation of OP-AA-108-115, “Operability Determination.”
    - Ineffective management oversight of the operability determination process.
- There was lack of Operations ownership to require formal documentation for safety-related operability concerns.
- Operator log entries related to technical specification related equipment operability were not in accordance with OP-AA-111-101, “Operating Narrative Logs and Records.”
    - Less than adequate training on log entry requirements for component/system operability.
    - Less than adequate management reinforcement of the operability determination documentation in operator logs.

Engineering Practices

- There was inadequate engineering standards use and adherence.
- There was less than adequate entry in and implementation of CC-AA-13, “Margin Management,” and ER-AA-2007, “Evaluating Margins.”
    - Inadequate procedure guidance in ER-AA-2030, “Conduct of Plant Engineering Manual,” regarding margin management.
    - Less than adequate training on implementation of CC-AA-13, “Margin Management,” and ER-AA-2007, “Evaluating Margins.”
    - Ineffective management oversight related to tracking, trending, and communication of remaining margin to decision-making bodies.
- There was lack of rigor in the monitoring program for safety-related piping for trending, tracking, and identification threshold for follow-up action determination related to external pipe corrosion.
    - Less than adequate procedure guidance related to trending, tracking, identification threshold, and follow-up action determination related to safety-related external pipe corrosion.
    - Inadequate preventative maintenance program for safety-related piping.
- There was less than adequate corporate oversight, within the Operations and Engineering areas, for Byron’s continuing SX issues relating to system health, operability, and repair work prioritization.

As part of the overall root cause evaluation process, the licensee had a separate independent team investigate the programmatic and organizational issues related to the event. The investigation report was included as an attachment to the licensee’s root cause evaluation. The investigation team provided an in-depth review of the licensee’s decision making processes, understanding and communication of risks, and aggregate impact of conditions. The investigation team summarized the event as follows:

> “The Byron SX event is the result of multiple latent conditions, which manifested in the SX piping being allowed to degrade to the point where it was declared inoperable, resulting in a dual unit shutdown. The timeline that begins in 1990 illustrates multiple opportunities the organization had to correct the corrosion issue. The timeline also illustrates that a formal program did not exist that provided specific guidance on external corrosion of raw water piping systems. The lack of this formal program contributed to the less than adequate trending of the pipe condition and corrosion rate over time. This has been identified as a programmatic

causal factor for the event. Of specific note, the timeline does begin in 1990 and, as described above, identifies organizational breakdowns that allowed the corrosion of this piping to go unaddressed for several years."

The investigation team reached the following conclusions:

- The failures to seek, understand, and require formal documentation of safety-related operability concerns was an operations fundamental breakdown and an organizational cause for this event.
- Multiple examples when the corrective action program was not valued or effectively used as a mechanism to identify, document, and subsequently input into priority work schedules was identified as a contributing cause to this event.
- Not understanding the true corrosion rate of the SX risers indicated a programmatic weakness in trending of corrosion of raw water systems. In addition corporate engineering oversight did not challenge this lack of trending of raw water/buried pipe systems and components.
- The over-reliance by station personnel to accept engineering decisions as facts, without providing the necessary challenge of assumptions and conclusions, was considered a contributing cause to this event.
- Inadequate use of the corrective action system, including inadequate leadership by the Management Review Committee to properly prioritize, drive timely actions, and follow through on identified SX issues, was a contributing cause to this event.
- Station personnel did not effectively apply the margin management process with the issues surrounding the SX risers. This tied directly into the contributing cause of a breakdown in the identification and analysis of SX issues.
- Multiple barriers failed throughout the organization in terms of challenging key decisions. This included missed opportunities with the Management Review Committee, Station Ownership Committee, and Plant Health Committee to recognize issues and challenge the methodology utilized to derive conclusions, in particular those related to degraded equipment and operability.
- The station organization was comfortable with systems and components as long as they were operable and did not put priority on correcting degraded conditions and maintaining design margins.
- There was opportunity within the corporate oversight functions to identify the informal mechanisms that Byron Station utilized to declare operability. This was identified as a contributing cause to this event.
- Decisions were made based on best effort ultrasonic pipe wall thickness readings with no basis for corrosion rates or remaining wall thickness measurements.
- Timeliness of follow-up inspections did not have the urgency needed based on the initial inspection results of the 0E SX riser.
- Coatings on service water piping were a weakness.

c. *Determine whether the licensee's root cause evaluation included consideration of prior occurrences of the problem and knowledge of prior operating experience.*

The inspectors determined that the root cause evaluation included consideration of prior occurrences of the problem and knowledge of prior operating experience. However, the inspectors noted one instance in which the licensee's review of operating experience did not adequately identify the applicability of the root causes of a previous industry event to the Byron event.

In the root cause evaluation, the licensee reviewed operating experience from internal (i.e., plant specific) as well as external (i.e., industry) sources relevant to the Byron Station event. The licensee's root cause evaluation team searched internal and external operating experience databases using key words "external" and "corrosion," and found information on several industry operating experience reports related to this event.

As discussed in Section 4OA3.3 of NRC Inspection Report 05000454/455/2007009, the NRC concluded that the licensee had failed to follow LS-AA-115, "Operating Experience Procedure," to implement timely corrective actions for external SX system piping corrosion in response to a service water piping corrosion event at a foreign reactor plant. In November 2006, the licensee received information that discussed a failure at a metal access port for a service water system at the foreign plant. This industry operating experience was also discussed in NRC Information Notice 2007-06, "Potential Common Cause Vulnerabilities in Essential Service Water Systems," issued on February 9, 2007. The inspectors characterized this performance deficiency as a finding of very low safety significance (i.e., Green) with an associated Non-Cited Violation (NCV) of 10 CFR 50, Appendix B, Criterion V, "Instructions, Procedures and Drawings." This industry operating experience issue was included in the root cause evaluation team's review and was used in the development of corrective actions for this event as well as corrective actions to address the extent of condition.

The root cause evaluation team also reviewed industry recommendations related to the 2002 Davis Besse Nuclear Power Station reactor vessel head degradation event for insights into causes and corrective actions for the Byron Station event. There were four root causes discussed in the operating experience for the Davis Besse event:

- There was a less than adequate safety focus (a production focus combined with taking minimum actions to meet regulatory requirements.)
- Implementation of the corrective action program was inadequate, as indicated by the following:
  - Addressing symptoms rather than causes,
  - Low categorization of conditions,
  - Inadequate cause determinations,
  - Inadequate corrective actions,
  - Inadequate trending.
- The organization failed to integrate and apply key industry information and site knowledge and to compare new information on plant conditions to baseline knowledge.
- Personnel did not comply with the boric acid corrosion control procedure and inservice inspection program, including failure to remove boric acid from the reactor pressure vessel.

The licensee concluded that "one root cause had some relevance to this event regarding implementation of the corrective action program, primarily issue prioritization (important issues prioritized too low)." The inspectors disagreed with this conclusion because there were multiple examples documented in NRC Inspection Report 05000454/455/2007009, the root cause evaluation, and several action requests indicating that all four root causes were relevant to the Byron event. The inspectors concluded that the root cause team did not critically evaluate the relevance of the Davis Besse reactor vessel head degradation event to the Byron event. Considering the licensee's earlier failure to implement timely corrective actions in response to operating experience for the service

water piping corrosion event at a foreign reactor plant, the inspectors concluded that additional focus on the evaluation of operating experience by the licensee may be warranted.

d. *Determine whether the licensee's root cause evaluation addressed extent of condition and extent of cause of the problem.*

The inspectors determined that the root cause evaluation adequately addressed the extent of condition and extent of cause of the problem. The inspectors reviewed the status of the licensee's actions to address the extent of condition and extent of cause and found no issues of significance.

In its root cause analysis, the licensee defined the "extent of condition" to include exposed piping in risk, safety, and generation related systems located in areas not accessed normally by personnel and subjected to a humid or wet environment, or ground water intrusion into areas that are normally dry. Considering this extent of condition, the root cause evaluation team developed a lengthy list of piping and components to assess and included it as an attachment to its report. The inspectors reviewed the list and found no concerns with the scope of the extent of condition review. As discussed below in Section 02.03.a, the inspectors noted one concern with respect to the licensee's tracking and trending of corrective actions for some of the piping and components on the licensee's extent of condition list. The inspectors noted that one of the three causes discussed in the licensee's extent of condition review had to do with less than adequate procedure guidance related to trending, tracking, identification threshold, and follow-up action determination related to safety related external pipe corrosion. The inspectors concluded that sufficient time has not been available to fully measure the licensee's success at addressing the above cause and the extent of condition.

e. *Determine whether the licensee's root cause evaluation, extent of condition, and extent of cause appropriately considered the safety culture components as described in Inspection Manual Chapter (IMC) 0305.*

The inspectors determined that, in general, the root cause evaluation, extent of condition, and extent of cause appropriately considered the safety culture components as described in IMC 0305. The inspectors noted, however, that the licensee's root cause evaluation and the safety culture components review had not adequately considered the failure of the licensee's self and independent assessment processes to identify the issues that caused or contributed to the event.

The inspectors noted that the root cause evaluation did not take into account the shortcomings of the licensee's self- and independent assessment processes. These two failed barriers were not addressed in the root cause evaluation. None of the line organization departments (e.g., Engineering, Operations, Work Control) had performed self-assessment activities that identified the issues (e.g., technical, programmatic, organizational) that caused or contributed to the event. The Nuclear Oversight Department not only failed to identify the issues that caused or contributed to the event, but also failed to identify the weaknesses in the line organization departments' self-assessments activities.

The licensee completed a Safety Culture Components Review as part of the root cause evaluation and in accordance with its corrective action program procedure. The inspectors concluded that the Review appropriately addressed the safety culture components relevant to the event, with one exception. In the Review, the licensee's staff concluded: "Self-assessments and the process that administers them were reviewed for potential weaknesses; none were found. Moreover, several of the corrective actions utilized this process as a tool to identify further weaknesses and determine effectiveness of corrective actions." Inasmuch as the licensee's self- and independent assessment processes failed to identify the issues that caused or contributed to the event before it occurred, the inspectors concluded that the Review did not correctly evaluate this Safety Culture component. The inspectors noted that to the extent self-assessment activities were incorporated into the corrective actions for this event, there has not yet been sufficient time to evaluate their effectiveness. Nonetheless, there is no regulatory requirement to complete this evaluation.

Separate from the root cause evaluation, the Nuclear Oversight Department reviewed several of the issues identified by the NRC Special Inspection team for learning opportunities to incorporate into its assessment activities. These actions were driven by Nuclear Oversight's procedure NO-AA-1001, "Nuclear Oversight Lessons Learned Assessment." However, this was not a comprehensive review of all of the root causes and contributing causes for the event, extent of condition, and extent of cause, and may therefore be of limited effectiveness.

f. Findings

No findings of significance were identified.

02.03 Corrective Actions

a. Determine whether the licensee specified appropriate corrective actions for each root/contributing cause or that the licensee evaluated why no actions were necessary.

The inspectors reviewed applicable corrective actions and corrective actions to prevent recurrence and determined that the licensee specified reasonable/appropriate corrective actions for each root/contributing cause. The inspectors also reviewed implementation of the corrective actions to verify completion status and found that the licensee in formulating corrective actions had not yet evaluated the need for or developed a clear plan to address the possible need to re-inspect piping that was close to but passed wall thickness acceptance criteria.

The inspectors evaluated the status of corrective actions identified for the piping and components on the licensee's extent of condition list. The condition of many of these piping and components has been evaluated by the licensee by non-destructive examination techniques, including visual examination and ultrasonic testing. Several of the non-destructive examination reports reviewed by the inspectors revealed pipe wall thicknesses to be at or near the 87.5 percent criteria. In response to the inspectors' questions, the licensee had not yet developed a clear plan going forward to re-inspect these sections of piping at some pre-defined frequency to establish a degradation rate and to monitor pipe wall loss over time. Taking such action would be prudent to enable the licensee to take corrective action to prevent recurrence of a similar event.

The licensee's root cause evaluation concluded that three root causes and twelve contributing causes applied to the SX degradation event. These causes are discussed above in Section 02.02.b. Corrective actions included the following:

- Implement a process for utilization of a designated challenger, as a minimum, at the following meetings; Plant Review Committee, Plant Health Committee, Management Review Committee, Site Ownership Committee, Plan of the Day, and E-2 Management Certification Meeting. This was a corrective action to prevent recurrence.

- Establish the proper level of rigor, challenge and expertise into the key decision making meetings at Byron Station. This was a corrective action to prevent recurrence.

- Develop and implement procedure guidance pertaining to trending, tracking, identification threshold, and follow-up action determination related to external pipe corrosion. This was a corrective action to prevent recurrence.

- Develop and implement expectations for the designated challenger at decision-making meetings that includes assignment of the challenger, roles, and responsibilities.

- Implement an assessment plan. The purpose of the assessment is to create the proper level of rigor, challenge, and expertise into the key decision making forums.

- Revise OP-AA-108-115, "Operability Determinations," procedure guidance to clearly define operability documentation requirements.

- Each senior reactor operator to perform a "read-and-sign" prior to performing the review of a degraded component for operability determination, confirming understanding of OP-AA-108-115, "Operability Determinations."

- Provide tabletop training to shift managers, senior reactor operators, and engineers to improve understanding of operability with respect to remaining margin or margin used or lost.

- Revise ER-AA-2030, "Conduct of Plant Engineering Manual," to include references to procedures CC-AA-13, "Margin Management," and ER-AA-2007, "Evaluating Margins," to ensure that tracking and trending of margin and clear communication requirements to ensure that key site decision-makers understand the magnitude of the various margins.

- Develop and implement written guidance pertaining to expectations regarding management oversight of margin management.

- Revise WC-AA-106, "Work Screening and Processing," for Byron Station to improve guidance on degraded piping/component work request processing.

- Revise ER-AA-335-015, “VT-2 Visual Examinations,” and ER-AA-2030, “Conduct of Plant Engineering Manual,” system walkdown and system manager turnover guidance, to include clear guidance related to identification thresholds and follow-up corrective actions regarding external pipe corrosion.

- Provide training on external corrosion sensitivity including threshold to trigger follow-up actions.

- Revise procedure guidance related to raw system monitoring to include external corrosion component.

- Perform an apparent cause evaluation to investigate deficiencies in calculations and assumptions used in SX piping wall thickness determinations.

- Revise ER-AA-2030, “Conduct of Plant Engineering Manual,” to include margin management and operability issue tracking specifically in the standard for system notebooks.

b. Determine whether the licensee prioritized the corrective actions with consideration of the risk significance and regulatory compliance.

The inspectors concluded that the licensee adequately prioritized the corrective actions with consideration of the risk significance and regulatory compliance. The licensee’s corrective actions appeared to be prioritized commensurate with the safety significance of the issues.

c. Determine whether the licensee established a schedule for implementing and completing the corrective actions.

The inspectors determined that the licensee adequately established a schedule for implementing and completing the corrective actions.

The licensee established a reasonable schedule for implementing the corrective actions. Corrective actions reviewed were complete with the exception of Effectiveness Reviews for corrective actions to prevent recurrence numbers 1 and 2. These Reviews are scheduled for completion in June 2009.

d. Determine whether the licensee developed quantitative or qualitative measures of success for determining effectiveness of the corrective actions to prevent recurrence.

The inspectors determined that the licensee developed appropriate quantitative or qualitative measures of success for determining effectiveness of the corrective actions to prevent recurrence. The licensee specified that Effectiveness Reviews be conducted for the three corrective actions to prevent recurrence discussed above.

For utilization of a designated challenger, effectiveness was to be measured by having no observations by the designated challenger being rated as not meeting expectations, or by having no missed opportunities based on poor decision-making as documented in meeting minutes or in the Corrective Action Program.

For establishing the proper level of rigor, challenge, and expertise into the key decision-making meetings, effectiveness was to be measured by performing a focused area self-assessment and reviewing department improvement plan action closures for appropriateness. No deficiencies identified in any objectives of the assessment and no inadequate department improvement plan action closures were established as the criteria for effective corrective action to prevent recurrence.

For procedure guidance related to external pipe corrosion, effectiveness was to be measured by evaluating the adequacy of procedure guidance, objective evidence that the procedure was being implemented as written, and no issue reports generated related to inadequate identification and follow-up action.

e. Findings

No findings of significance were identified.

40A5 Other

(Closed) Violation 05000454/455/2007009-02, "Failure to Implement Timely Corrective Actions for Degraded SX Riser Piping"

(Closed) Violation 05000454/455/2007009-03, "Inadequate Design Margins for Continued Operation of SX Riser Pipes"

The inspectors determined that the licensee's response to the Notice of Violation provided an accurate description of the root causes, corrective actions taken, and other aspects of the violations. No other instances of the violations were identified. These violations are closed.

40A6 Meetings, Including Exit

.1 Exit Meeting Summary

The inspectors presented the inspection results to Mr. B. Adams and other members of licensee management on January 23, 2009. The licensee confirmed that no proprietary information was reviewed during this inspection.

.2 Regulatory Performance Meeting

On January 23, 2009, the NRC met with the licensee to discuss its performance in accordance with IMC 0305, Section 06.05.a.1. During this meeting, the NRC and licensee discussed the issues related to the White finding that resulted in Byron Station, Units 1 and 2, being placed in the Regulatory Response Column of the Action Matrix. This discussion included the causes, corrective actions, extent of condition, extent of cause, and other planned licensee actions.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee

D. Hoots, Site Vice President
B. Adams, Plant Manager
A. Daniels, Nuclear Oversight Manager
C. Gayheart, Operations Manager
D. Gudger, Regulatory Assurance Manager
G. Gugle, Systems Engineering
E. Hernandez, Plant Engineering Manager
T. Hulbert, Regulatory Assurance Coordinator
R. Lloyd, Operations
W. Perchiazzi, Design Engineering Manager
J. Virnich, Engineering Programs
L. Zurawski, NSSS Group Leader

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

None		

Closed

05000454/2007009-02; 05000455/2007009-02	VIO	Failure to Implement Timely Corrective Actions for Degraded SX Riser Piping (Section 40A5)
05000454/2007009-03; 05000455/2007009-03	VIO	Inadequate Design Margins for Continued Operation of SX Riser Pipes (Section 40A5)

Discussed

05000454/2007-002-00; 05000455/2007-002-00	LER	Technical Specification Required Shutdown of Unit 1 and Unit 2 Due to an Ultimate Heat Sink Pipe Leak Common to Both Units (Section 02.01.a)
05000454/2007009-01; 05000455/2007009-01	NCV	Operating Experience Procedure Not Followed for Service Water Corrosion Event (Section 02.02.c)

LIST OF DOCUMENTS REVIEWED

The following is a list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspectors reviewed the documents in their entirety, but rather, that selected sections of portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

IP 95001 Inspection for One or Two White Inputs in a Strategic Performance Area

- Letter from J. Caldwell, (U.S. NRC), to C. Pardee (Exelon Generation Company, LLC), Subject: Byron Station – Final Significance Determination for a White Finding and Notice of Violation; NRC Inspection Report No. 05000454/2007009(DRS) and 05000455/2007009(DRS), April 1, 2008
- Letter from D. Hoots, (Exelon Generation Company, LLC), to U.S. Nuclear Regulatory Commission, Subject: Response to Notice of Violation EA-08-046, May 1, 2008
- Root Cause Evaluation 00687024, "Through Wall Pipe Leak on the OC SX Riser Piping Upstream of the 0SX163C," December 12, 2007
- BB PRA-017.75B, "Byron Essential Service Water (SX) Cooling Tower Riser Pipe Degradation Phase 3 Significance Determination Process (SDP) Assessment," Revision 1
- Focus Area Self Assessment, "Byron Station – NRC SX Supplemental Inspection 95001 Readiness Focused Area Self-Assessment (FASA) Report," no date
- Safety Culture Components Review for Root Cause Evaluation 00687024, "Through Wall Pipe Leak on the OC SX Riser Piping Upstream of the 0SX163C," no date
- Nuclear Oversight Learning Opportunity Report, "NRC Special Inspection Team Potential Green NCV SX Pipe Evaluation Did Not Consider Thermal or Functional Capability," March 1, 2008
- Nuclear Oversight Learning Opportunity Report, "NRC Special Inspection Team Potential NCV Operability Evaluation 07-009 Did Not Properly Apply ASME [American Society of Mechanical Engineers] III, Appendix F, for Compressive and Buckling Stresses," December 12, 2007
- Nuclear Oversight Learning Opportunity Report, "NRC Special Inspection Team Potential NCV VT-2 Inspection Not Critical of Bolting Corrosion and Degradation," November 30, 2007
- Byron Site Policy Memo #200.52, "Designated Challenger at Meetings," January 2, 2008
- ER-AA-2030, "Conduct of Plant Engineering Manual," Revision 7
- OP-AA-108-115, "Operability Determinations," Revision 6
- ER-AA-335-015, "VT-2 Visual Examination," Revision 9
- NES-MS-14.1, "Graded Approach for Identifying Degraded Service Level II Coating and Corrosion Related Issues on Piping," Revision 1
- ER-AA-5400, "Buried Piping and Raw Water Corrosion Program Guide," Revision 1
- OP-AA-108-115-1002, "Supplemental Consideration for On-Shift Immediate Operability Determinations," Revision 1
- EC 367939, "Evaluation of Indications on Line OSX01AB-48" Near Valve OSX138B," October 27, 2007
- EC 367983, "Minimum Wall OSX908AB-24" Evaluation NDE [Non-destructive Examination] Report 2007-507," October 26, 2007
- W.O. 1072684, "Replace Thinned Wall Pipe at SX Tower," (OSX97AB), October 23, 2007
- W.O. 1072688, "Replace Thinned Wall Pipe at SX Tower," (OSX97AG), October 23, 2007
- AR 00741614, "Additional Review Needed Based on Byron Nuclear Safety Review Board Notes"
- AR 00690364, "Nuclear Oversight Learning Opportunity – SX Piping Leak"

- AR 00762353, “Nuclear Oversight Review of Raw Water System Issues – Nuclear Oversight Issues”
- AR 00715626, “Issues With the Essential Service Water Cooling Tower Root Cause Report”
- AR 00687024, “Through Wall Leak SX Riser Pipe Upstream of Valve (IR 716194),” October 19, 2007 (includes associated corrective actions)
- AR 00716194, “IR 687024 SX Riser Continuation of Action Assignments,” October 19, 2007 (includes associated corrective actions)
- AR 00870736, “Wrong Equipment Part Number Recorded on Several NDE Reports,” January 22, 2009

LIST OF ACRONYMS USED

AR	Action Request
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
FASA	Focused Area Self-Assessment
IMC	Inspection Manual Chapter
IP	Inspection Procedure
IR	Issue Report
LER	Licensee Event Report
NCV	Non-Cited Violation
NDE	Non-destructive Examination
NRC	U.S. Nuclear Regulatory Commission
PARS	Publicly Available Records
SDP	Significance Determination Process
SX	Essential Service Water System
WO	Work Order
VIO	Violation