

February 7, 2007

EA-06-291

Mr. Christopher M. Crane  
President and Chief Nuclear Officer  
Exelon Nuclear  
Exelon Generation Company, LLC  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: FINAL SIGNIFICANCE DETERMINATION FOR A WHITE FINDING  
AND NOTICE OF VIOLATION; NRC INSPECTION REPORT  
NO. 05000461/2007006(DRS) FOR CLINTON POWER STATION

Dear Mr. Crane:

The purpose of this letter is to provide you the final results of our significance determination of the preliminary Greater Than Green finding identified in Inspection Report No. 05000461/2006011(DRS). The inspection finding was assessed using the Significance Determination Process and was preliminarily characterized as Greater Than Green, a finding of greater than very low safety significance, resulting in the need for further evaluation to determine significance; and therefore, the need for additional NRC action. This Greater Than Green finding involved the failure to select an appropriate method for calculating the minimum elevation (i.e., the analytical level) of water above the high pressure core spray (HPCS) pump suction line to preclude vortex formation and subsequent air entrainment in the pump's suction. As a result, the analytical level would result in significant air entrainment potentially causing the HPCS to be incapable of completing its safety function.

At our request, a Regulatory Conference was held on December 19, 2006, to further discuss your views on this issue. The public meeting summary, including the handouts, can be found in the Agencywide Document Access and Management System (ADAMS) ML063520445. During the meeting, your staff described the results of recent scaled model testing. Specifically, the scaled model testing showed that a localized depression briefly formed which immediately collapsed and resulted in significant (about 24 percent) air being entrained in the suction piping. You determined that this air/water mixture would result in a slowed level decrease in the reactor core isolation cooling tank resulting in a delay in transferring suction to the suppression pool.

However, your calculations showed that the suction valve from the suppression pool would open and suction would be primarily from the suppression pool prior to the air reaching the suction of the HPCS pump. Therefore, you concluded that the HPCS pump would be capable of performing its safety function. In assessing the test model results, you assumed that flow

would not be characterized as slug flow, that is, the flow would be less than 24 percent air entrained. Your conclusion was based on: (1) visual confirmation during Alden Laboratory Testing; (2) visual comparison of test results against a “known” flow having 24 percent air entrainment; and (3) a computer model (RELAP) prediction that slug flow would exist above 24 percent. The NRC identified the following concerns with your conclusion:

- During testing at Alden Laboratory, the pump was stopped immediately (about 5 seconds) upon visual observation of ‘break through’, i.e., air becoming entrained in the suction pipe. This was done to preserve and prevent damage to the test pump. This quick stopping did not allow time to verify the absence of slug flow.
- The visual comparison of the test results against a “known” flow having 24 percent air entrainment was short in duration. This visual comparison may not represent actual test or in-plant flow conditions. With flow and flow conditions unstable and oscillating, this short time duration did not provide definitive proof that slug flow would not exist. Actual void fraction measurements may typically have as much as 8 percent uncertainty.
- The computer model (RELAP) is a generic 2-phase flow code and is not necessarily tuned or calibrated to this exact scenario. To consider results ‘exact’ and without any consideration of analytical error is imprudent.

The assumption of 24 percent air entrainment was key in assessing the ability of HPCS to perform its function for several reasons. First, the 24 percent provides a basis for the rate of decrease in the RCIC tank. A greater void fraction would slow down the rate of change, increasing the time to the swap-over point. This increase in time, would allow the air wave front to travel further down the line and potentially reach pump suction prior to full opening of the suppression pool suction valve. Secondly, although your staff calculated a 2-phase fluid flow velocity, an increase in void fraction will increase the transport velocity, increasing the possibility of air arrival at the pump. Lastly, should slug flow exist, there is a potential for system waterhammer affecting system piping or the HPCS pump or both.

In summary, the staff does not concur with your evaluation regarding the amount of air entrainment; and therefore, does not agree with your assessment on the past operability of the HPCS pump. Your assessment is not conclusive, complete or robust, in that the basis for 24 percent was not well founded. Small changes to these assumptions may significantly impact the conclusion regarding past HPCS pump operability.

In addition, during the Regulatory Conference, you also provided your assessment of the significance of the finding. Specifically, you provided information regarding the potential for operators to throttle HPCS flow and the estimated contribution to the risk from fire events. The NRC reviewed the information regarding throttling the HPCS injection valve and determined

that it should be considered in the final significance determination. Based on the discussion at the Regulatory Conference, operators would be directed to throttle HPCS in response to transient (i.e., non- Loss of Coolant Accidents and non- Anticipated Transient Without a Scram) scenarios. If operators successfully throttle the HPCS injection valve, the system flow rate will be low enough that air entrainment during suction swap-over to the suppression pool would no longer be a concern. For the final significance determination, the NRC assumed that HPCS would fail in response to transient initiating events only if the operator failed to properly throttle the HPCS injection valve. For all other initiating events, HPCS was assumed to fail during the suction transfer, consistent with the assumption in the preliminary significance determination. Given the inherent uncertainty in estimating human error probabilities, the NRC used its best estimate of  $2.6E-2$  for the human error probability in the final significance determination.

The NRC also reviewed the estimation of fire risk contribution that you provided and determined that it was the best available information; and therefore, it was used directly in the final significance determination.

After considering the information presented at the Regulatory Conference and the additional information you provided in your letter dated December 21, 2006, the NRC has concluded that the inspection finding is appropriately characterized as White, an issue with low to moderate increased importance to safety, which may require additional NRC inspections. Using the estimation of fire risk contribution and best estimate for human error probability, the NRC determined the total change in core damage frequency to be about  $4.4E-6$  per year.

You have 30 calendar days from the date of this letter to appeal the staff's determination of significance for the identified White finding. Such appeals will be considered to have merit only if they meet the criteria given in NRC Inspection Manual Chapter 0609, Attachment 2.

The NRC has also determined that the failure to ensure the adequacy of design of the HPCS system by performance of design reviews or by use of alternate or simplified calculational methods is a violation of Title 10 Part 50, Appendix B, Criteria III, as cited in the enclosed Notice of Violation (Notice). The circumstances surrounding the violation are described in detail in Inspection Report No. 05000461/2006011(DRS). In accordance with the NRC Enforcement Policy, NUREG-1600, the Notice of Violation is considered escalated enforcement action because it is associated with a White finding.

You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response.

Because plant performance for this issue has been determined to be in the regulatory response band, we will use the NRC Action Matrix, to determine the most appropriate NRC response for this event. We will notify you, by separate correspondence, of that determination.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure and response will be made available electronically for public inspection in the NRC Public Document Room or from the Publically 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/*

James L. Caldwell  
Regional Administrator

Docket No. 50-461  
License No. NPF-62

Enclosure:  
Notice of Violation

cc w/encl:     Site Vice President - Clinton Power Station  
                  Plant Manager - Clinton Power Station  
                  Regulatory Assurance Manager - Clinton Power Station  
                  Chief Operating Officer  
                  Senior Vice President - Nuclear Services  
                  Vice President - Operations Support  
                  Vice President - Licensing and Regulatory Affairs  
                  Manager Licensing - Clinton Power Station  
                  Senior Counsel, Nuclear, Mid-West Regional Operating Group  
                  Document Control Desk - Licensing  
                  Assistant Attorney General  
                  Illinois Emergency Management Agency  
                  State Liaison Officer, State of Illinois  
                  Chairman, Illinois Commerce Commission

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Sincerely,

*/RA/*

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Regional Administrator

Docket No. 50-461  
License No. NPF-62

Enclosure:  
Notice of Violation

cc w/encl: Site Vice President - Clinton Power Station  
Plant Manager - Clinton Power Station  
Regulatory Assurance Manager - Clinton Power Station  
Chief Operating Officer  
Senior Vice President - Nuclear Services  
Vice President - Operations Support  
Vice President - Licensing and Regulatory Affairs  
Manager Licensing - Clinton Power Station  
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DATE	2/2/07	2/02/07	2/2/07	2/2/07	2/2/07	2/7/07

**OFFICIAL RECORD COPY**

<sup>1</sup> HQ concurrence received via e-mail from D. Starkey, OE on February 2, 2007

Letter from J. Caldwell to C. Crane dated February 7, 2007

SUBJECT: FINAL SIGNIFICANCE DETERMINATION FOR A WHITE FINDING  
AND NOTICE OF VIOLATION; NRC INSPECTION REPORT  
NO. 05000461/2007006(DRS) FOR CLINTON POWER STATION

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## NOTICE OF VIOLATION

Exelon/AmerGen Energy Company, LLC  
Clinton Power Station

Docket No. 50-461  
License No. NPF-62  
EA-06-291

During an NRC inspection completed on November 17, 2006, a violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

Title 10 Part 50, Appendix B, Criteria III states, in part, that measures shall be established to assure that applicable regulatory requirements and the design basis, as defined in § 50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies are correctly translated into specifications, drawings, procedures, and instructions.

It further states that design control measures shall provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program.

Title 10, Part 50.2 states, in part, that "design bases" means that information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted "state of the art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.

Contrary to the above, prior to August 12, 2006, the licensee had not ensured the adequacy of design of the high pressure core spray (HPCS) system by performance of design reviews or by use of alternate or simplified calculational methods. Specifically, the initiation of suction swap-over from the reactor core isolation cooling tank to the suppression pool, a controlling parameter to ensure continued function of the HPCS pump, was required to occur at 740.19 feet as derived by calculation IP-M-384, Revisions 0, 1, and 1B. However, this calculated value did not prevent significant air entrainment in the suction of the HPCS pump and subsequent loss of function of the HPCS pump.

This violation is associated with a White SDP finding.

Pursuant to the provisions of 10 CFR 2.201, Exelon/AmerGen Energy Company, LLC is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region III, and a copy to the NRC Resident Inspector at the Clinton Power Station, within 30 days of the date of the letter transmitting this Notice of Violation (Notice).

This reply should be clearly marked as a "Reply to a Notice of Violation; EA-06-291 and should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days.

Dated this 7<sup>th</sup> day of February 2007