Dominion Energy Kewaunee, Inc.
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Dominion

November 2, 2006

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Serial No. 06-497A
NL&OS/CDS: R3
Docket No. 50-305
License No. DPR-43

DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
SUBJECT: RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST – 226: INCREASE IN TECHNICAL SPECIFICATION MINIMUM REQUIRED REFUELING WATER STORAGE TANK BORON CONCENTRATION

In accordance with 10 CFR 50.90, Dominion Energy Kewaunee, Inc. (DEK) submitted a request for an amendment to the Kewaunee Power Station (KPS) Technical Specifications (TS) (Reference 1). The proposed amendment would increase the minimum required boron concentration in the refueling water storage tank (RWST) from 2400 parts per million (ppm) to 2500 ppm. Subsequent to DEK's submittal, the NRC staff requested additional information to complete its review.

Attachment 1 provides the questions asked by the NRC staff with DEK's responses. The RAI responses do not change the significant hazards determination for the proposed amendment discussed in Reference 1.

In Reference 1, DEK requested approval of the proposed amendment by September 15, 2006 to support implementation of the proposed change prior to the end of the KPS Fall 2006 refueling outage (Refueling Outage 28). Since the time of the original submittal, DEK has completed an analysis to validate that this change was not required to support startup of KPS following the Fall 2006 refueling outage. Therefore, DEK requests a change to the previously submitted approval date from September 15, 2006 to December 15, 2006. DEK also requests 60 days to implement this change once it is approved.

In accordance with 10 CFR 50.91(b), a copy of this letter, with attachments, is being provided to the designated Wisconsin official.

If you have any questions, please contact Mr. Craig Sly at 804-273-2784.

Very truly yours,

Gerald T. Bischof
Vice President – Nuclear Engineering

Reference

1. Letter from Eugene S. Grecheck (DEK) to Document Control Desk (NRC), "License Amendment Request 226 – Increase in Technical Specification Minimum Refueling Water Storage Tank Required Boron Concentration," dated June 28, 2006. (ADAMS Accession No. ML061800307)

Attachment

1. Response to NRC Request for Additional Information Regarding License Amendment Request – 226, Increase in Technical Specification Minimum Required Refueling Water Storage Tank Boron Concentration.

Commitments made in this letter: None

cc: Regional Administrator
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COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Gerald T. Bischof, who is Vice President, Nuclear Engineering of Dominion Energy Kewaunee, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 2nd day of November, 2006.

My Commission Expires: August 31, 2008.

Margaret B. Bennett
Notary Public

(SEAL)

Attachment 1

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST – 226: INCREASE IN TECHNICAL SPECIFICATION MINIMUM REQUIRED REFUELING WATER STORAGE TANK BORON CONCENTRATION

KEWAUNEE POWER STATION

DOMINION ENERGY KEWAUNEE, INC.

ATTACHMENT 1

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST – 226: INCREASE IN TECHNICAL SPECIFICATION MINIMUM REQUIRED REFUELING WATER STORAGE TANK BORON CONCENTRATION

INTRODUCTION

Pursuant to 10 CFR 50.90, Dominion Energy Kewaunee, Inc. (DEK) requested an amendment to the Kewaunee Power Station (KPS) Facility Operating License (DPR-43). The proposed amendment would change KPS TS 3.3.b.3.B and TS 3.3.b.4.A to increase the minimum required boron concentration in the refueling water storage tank (RWST) from 2400 parts per million (ppm) to 2500 ppm.

On August 22, 2006 DEK received five questions related to this amendment request. Each question and DEK's response is provided below.

Question 1:

Please provide the analyses justifying why the current minimum boron concentration of 2400 ppm in the Refueling Water Storage Tank (RWST) is not sufficient and why 2500 ppm will be sufficient to ensure that the containment sump boron concentration following a postulated large break loss-of-coolant accident would be greater than that required to maintain subcriticality of the Cycle 28 reload core during recirculation of coolant from the containment sump.

Response:

In Reference 1, DEK submitted a request for an amendment to the KPS Technical Specifications (TS) to increase the minimum allowable refueling water storage tank (RWST) boron concentration from 2400 ppm to 2500 ppm. Since the time of the original submittal, DEK has completed an analysis that supports the conclusion that this change was not required to support startup of KPS following the Fall 2006 refueling outage (Refueling Outage 28). Therefore, the current minimum boron concentration of 2400 ppm in the RWST is sufficient to ensure that the Cycle 28 reload core will remain subcritical in the event of a large break loss-of-coolant accident (LBLOCA). However, future reload cores will challenge this limitation, so increasing the minimum required RWST boron concentration remains advisable. Therefore, a detailed response to Question 1 is presented below to further clarify the justification for the proposed increase in RWST boron concentration.

The KPS Updated Safety Analysis Report (USAR) Section 14.3, Reactor Coolant System Pipe Ruptures (Loss-of-Coolant Accident), requires demonstration of the adequacy of the emergency core cooling system (ECCS) to provide long-term core cooling. Analyses that demonstrate the adequacy of long-term cooling provided by the ECCS assume maintenance of subcriticality following a LOCA. USAR Section 14.3 states that, "An average RCS/sump mixed boron concentration is calculated to ensure that the post-LOCA core remains subcritical."

Post-LOCA subcriticality is verified for each reload core as part of the reload design and analysis process. The need to develop a calculation of the post-LOCA sump boron concentration, and to compare the results of this calculation to reload-specific critical boron concentration at post-LOCA conditions, was communicated to utilities by a Westinghouse technical bulletin. The bulletin described the need for utilities to develop reload procedures to: (a) calculate the critical core boron concentration at conditions expected during the long-term recirculation phase following a LOCA, and; (b) calculate a mass-weighted average boron concentration in the sump which considers all credible sources of water that may discharge to the sump following a LOCA. The post-LOCA sump boron concentration analysis determines the minimum boron concentration that is predicted to be experienced following a LBLOCA, assuming tank volumes and solute concentrations are controlled in accordance with their respective limits. The predicted post-LOCA sump boron concentration is described as a function of hot full power (HFP) critical boron concentration.

Following a small or large break loss-of-coolant accident (SBLOCA or LBLOCA), fluid from various volumes accumulate in the containment sump. At KPS, these volumes include the RWST, the caustic addition standpipe, the safety injection accumulators (SIAs), the high head safety injection system piping (SI Piping), the low head/residual heat removal piping (RHR Piping), the reactor coolant system (RCS), and potentially unborated water in the containment sump during normal operation. The RWST, SIAs, SI Piping, RHR Piping, and the RCS contain boric acid solution, whereas the caustic addition standpipe contains sodium hydroxide solution.

Depending on the magnitude of the LOCA, some or all of the liquid contained in these volumes will be introduced into the containment, and will ultimately accumulate in the containment sump. In the design basis LBLOCA, all of the liquid in these volumes (less any unusable volume) is assumed to be transferred into the containment. It is necessary to have a sufficiently high boric acid concentration in the sump mixture to ensure that the reactor remains subcritical on boron alone. (For the design basis LBLOCA, the Westinghouse evaluation model assumes no Rod Control Cluster Assembly (RCCA) insertion.)

A mass-weighted average sump boron concentration is calculated by summing the product of the water mass (i.e., volume multiplied by density) and the boron concentration of each volume, and dividing by the sum of the masses. Uniform mixing of all tank contents in the sump is assumed. The limit for the maximum allowable critical boron concentration at post-LOCA core conditions is presented as a function of the minimum critical boron concentration at pre-LOCA conditions. Conservative assumptions regarding pre-LOCA and post-LOCA coolant temperature, control rod position, xenon concentration, and cycle burnup are employed in the analysis.

In the preliminary Westinghouse post-LOCA sump boron concentration analysis, which was being prepared contemporaneous with Reference 1, an RWST boron concentration of 2400 ppm resulted in a calculated post-LOCA sump boron concentration that was lower than the calculated maximum critical boron concentration for the reload core at post-LOCA core conditions (The calculation was performed at the low end-of-Cycle 27 burnup window. More favorable Cycle 28 post-LOCA subcriticality results would be predicted for the actual end-of-Cycle 27 burnup). However, when an RWST boron concentration of 2500 ppm was employed, the resulting calculated post-LOCA sump boron concentration was greater than the calculated maximum critical boron concentration for the reload core at post-LOCA core conditions. Westinghouse estimates of Cycle 28 reload safety analysis results (low end-of-Cycle 27 burnup window), which were developed around the time Reference 1 was being prepared, are shown below for illustration.

Condition	**Results (ppm boron)**
Minimum Pre-LOCA	1419
Post-LOCA Limit (2500 ppm RWST)	2260
Maximum Post-LOCA (68° F) Core Critical	2208
Maximum Post-LOCA (212° F) Core Critical	2241
Margin	+19
Condition	**Results (ppm boron)**
Minimum Pre-LOCA	1419
Post-LOCA Limit (2400 ppm RWST)	2185
Maximum Post-LOCA (68° F) Core Critical	2208
Maximum Post-LOCA (212° F) Core Critical	2241
Margin	-56*

* Maximum post-LOCA core critical boron concentration exceeds the post-LOCA boron concentration limit.

Question 2:

Please justify how the safety analyses that use the minimum RWST boron concentration of 2400 ppm (e.g. post-LOCA subcriticality and MSLB accident shutdown margin) will be "unaffected and will remain bounding and valid" if the minimum RWST boron concentration is being increased from 2400 ppm to 2500 ppm.

Response:

It is first necessary to clarify Question 2, since the question cites post-LOCA subcriticality as among the safety analyses that are "unaffected and [that] will remain bounding" if the minimum RWST boron concentration is increased from 2400 ppm to 2500 ppm. As described in Section 3.0, "Background," of Reference 1, "the effect of this change is to further constrain the allowable RWST boron concentration within the range of RWST boron concentrations already considered in the plant design and licensing bases." Section 4.0 of Reference 1, "Technical Analysis," goes on to state that, "As a result of selecting the revised required minimum RWST boron concentration within the current minimum and maximum limits, the safety analyses that use the minimum (2400 ppm) or maximum (2625 ppm) RWST boron concentration as a design input will be unaffected and will remain bounding and valid <u>except for the post-LOCA sump boron concentration analysis."</u> The reasons for this exception are discussed below.

For a given reload core, an increase in the minimum RWST boron concentration results in an increase in the margin by which the plant is calculated to be shutdown following a LBLOCA. Thus, an increase in the actual RWST boron concentration is a conservative change with respect to post-LOCA subcriticalty. However, post-LOCA subcriticality is a KPS design and licensing basis criterion governing the establishment of RWST volume and boron concentration (i.e., USAR Section 14 states that, "An average RCS/sump mixed boron concentration is calculated to ensure that the post-LOCA core remains subcritical"). Therefore, it is necessary to increase the minimum RWST boron concentration specified in Technical Specifications in order to <u>credit</u> an increased RWST boron concentration in the post-LOCA subcriticality analysis. With this clarification, Question 2 can now be addressed in the context of safety analyses other than post-LOCA subcriticality.

Safety analyses that use the minimum RWST boron concentration of 2400 ppm (e.g. LOCA and MSLB accident analyses) are unaffected and remain valid if the minimum required RWST boron concentration is increased from 2400 ppm to 2500 ppm. This is because these accident analyses require the injection of emergency core cooling system (ECCS) water for accident mitigation. The ECCS water is borated, and is injected into the reactor coolant system (RCS) to maintain core inventory for core cooling, and to ensure that the reactor is adequately shutdown. If the boron concentration of the ECCS injection water is increased (e.g., to 2500 ppm), then the reactor coolant system (i.e., the system that is receiving the injected ECCS water) will have a higher post-accident boron concentration than it would have if the ECCS injection water had a boron concentration of 2400 ppm. On this basis, it may be concluded that the safety analyses that use the minimum RWST boron concentration as a design input (e.g., LOCA and MSLB) will be unaffected and will remain bounding and valid if the minimum RWST boron concentration is increased from 2400 ppm to 2500 ppm.

For the boron precipitation analysis, higher assumed values of RCS and RWST boron concentration are conservative; that is, boron precipitation is more likely to occur during a loss-of-coolant accident when higher initial boron concentrations are present in the RCS and RWST. As described below in the response to Question 4, the boron precipitation analysis conservatively assumes injected ECCS fluid at the maximum RWST boron concentration (i.e., 2625 ppm). Further, the analysis assumes an at-power critical boron concentration (initial RCS condition prior to the accident) of 2400 ppm, which conservatively bounds the maximum plausible at-power critical boron concentration for reload cores. Thus, in the case of the post-LOCA boron precipitation analysis, selection of a revised required minimum RWST boron concentration within the current range of allowable boron concentrations (i.e., 2400 ppm to 2625 ppm) ensures that the safety analysis will remain bounding and valid. The adequacy of the existing analysis of post-LOCA boron precipitation is also addressed in Question 4 (below).

The same logic applied to LBLOCA, MSLB, and boron precipitation is applied in the Reference 1 evaluation of the effect of the proposed change on post-LOCA containment spray and containment sump pH analysis, and on equipment environmental qualification. In each case, to "further constrain the allowable RWST boron concentration within the range of RWST boron concentrations already considered in the plant design and licensing bases" ensures acceptable safety analysis results.

In summary, the current accident analyses assume RWST boron concentration is controlled to within the range of 2400 ppm to 2625 ppm. If the minimum required RWST boron concentration is increased to 2500 ppm, such that the range becomes 2500-2625 ppm, the current accident analyses that assume a minimum RWST boron concentration of 2400 ppm will remain valid and bounding. Because post-LOCA subcriticality is part of the KPS design and licensing basis, it is necessary to increase the Technical Specification minimum RWST boron concentration (Reference 1) in order to credit an increased RWST boron concentration in the post-LOCA subcriticality analysis.

Question 3:

Please provide the Post-LOCA Sump Boron Concentration Limit analysis mentioned in Section 4.4 that demonstrates that 2500 ppm is a sufficient value for the minimum RWST boron concentration to ensure post-LOCA core subcriticality with the increased core reactivity expected for Cycle 28.

Response:

See response to Question 1.

Question 4:

What is the reason for using 2400 ppm for boron concentration in the reactor coolant system (described in Section 4.3)? Is this value related, in any way, to the 2400 ppm value for the minimum RWST boron concentration? If so, please provide a new post-LOCA Boron Precipitation analysis that uses 2500 ppm for maximum full power critical boron concentration in the RCS instead of 2400 ppm.

Response:

Question 4 requests clarification of the adequacy of the existing analysis of post-LOCA boron precipitation in light of the proposed increase in minimum RWST boron concentration. For the boron precipitation analysis, higher RCS and RWST boron concentration values are conservative. The analysis of post-LOCA boron precipitation conservatively assumes that fluid injected by the ECCS is at the maximum RWST boron concentration (i.e., 2625 ppm). Furthermore, the analysis assumes an at-power critical boron concentration (initial RCS condition prior to the accident) of 2400 ppm, which conservatively bounds the maximum plausible at-power critical boron concentration for reload cores. This value was selected because the minimum RWST boron concentration conservatively bounds achievable reload values of maximum at-power critical RCS boron concentration.

After the minimum RWST boron concentration is increased from 2400 ppm to 2500 ppm, the value of initial (pre-LOCA) at-power critical RCS boron concentration assumed in the post-LOCA boron precipitation analysis (i.e., 2400 ppm) will continue to conservatively bound reload values of maximum at-power critical boron concentration. At-power critical boron concentrations for KPS reload core designs are typically less than 2100 ppm with no xenon, and less than 1700 ppm with equilibrium xenon. The reload safety evaluation process will continue to confirm that at-power critical boron concentrations for reload cores are less than the boron concentration assumed in the boron precipitation analysis (i.e., 2400 ppm). On this basis, it is concluded that there is no requirement for a new post-LOCA boron precipitation analysis to be performed using a higher assumed value of maximum full power critical boron concentration.

Question 5:

In the submittal (Section 4.5) a statement is made that "the containment spray and post-LOCA containment sump pH analysis limits continue to be satisfied with an increase in minimum RWST boron concentration to 2500 ppm". In this context the word "satisfied" means that the value of sump pH will create an environment which will produce release of optimal amount of elemental iodine from the sump water and the corrosion of metallic surfaces will be minimized. The licensee should provide the actual values for pH which allow creation of such an environment.

Response:

The results of the current KPS analysis for post-LOCA containment sump pH demonstrate that sump pH will remain within the acceptable post-LOCA sump pH range of 7.0 to 9.5, assuming upper and lower bounding values of RWST boron concentration of 2625 ppm and 2400 ppm, respectively. The post-LOCA sump pH range of 7.0 to 9.5 was established to ensure that radioactive iodine forms chemical species that remain in solution and, therefore, do not adversely affect post-LOCA radiological dose analysis results. The acceptable range of post-LOCA sump pH was also established to minimize corrosion of metallic surfaces within containment. The proposed change (i.e., increasing the minimum RWST boron concentration to 2500 ppm) will have no adverse impact on the results of the containment sump pH analysis, since the pH remains within the current containment sump pH analysis range for RWST boron concentration (i.e., 2500 ppm is within the range of 2400 ppm to 2625 ppm).

As an example, the actual KPS RWST boron concentration could be controlled to a minimum boron concentration greater than 2400 ppm (e.g., 2550 ppm) in order to logistically support the minimum required refueling water boron concentration of 2500 ppm specified in the Core Operating Limits Report (COLR). This control would be consistent with the existing KPS safety analyses, since it constrains the allowable RWST boron concentration within the range of RWST boron concentrations already considered in the plant design and licensing bases. Therefore, with the proposed increase in RWST boron concentration from 2400 ppm to 2500 ppm, the current containment sump pH analyses will remain valid, and the acceptance criterion of a sump pH between 7.0 and 9.5 will be satisfied.

Reference:

1. Letter from E. S. Grecheck (DEK) to Document Control Desk (NRC), "License Amendment Request 226 – Increase in Technical Specification Minimum Refueling Water Storage Tank Required Boron Concentration," dated June 28, 2006. (ADAMS Accession No. ML061800307)