ATTACHMENT (1)

ANALYSIS OF THE PROPOSED CHANGES

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1.0 SUMMARY DESCRIPTION

Calvert Cliffs Nuclear Power Plant (CCNPP) requests an amendment to Renewed Operating License Nos. DPR-53 and DPR-69 for Calvert Cliffs Units 1 and 2 by revising Technical Specification 3.5.5, "Trisodium Phosphate (TSP)." Calvert Cliffs intends to replace trisodium phosphate (TSP) as the buffering agent for pH control during recirculation with sodium tetraborate decahydrate (STB) ($Na_2B_4O_7 \cdot 0H_2O$). The purpose of this change is to minimize the potential for sump screen blockage concerns under post loss-of-coolant accident (LOCA) conditions due to a potential adverse chemical interaction between TSP and certain insulation materials used in Containment. The use of TSP ensures a neutral to mildly alkaline pH for the solution recirculated in the containment sump. The neutral to mildly alkaline pH minimizes the evolution of iodine and minimizes the occurrence of chloride and caustic stress corrosion on mechanical systems and components exposed to the fluid. The proposed use of STB serves this same function, maintaining the intent of the Technical Specification, but results in less predicted precipitate generation and resultant sump screen blockage.

2.0 DETAILED DESCRIPTION

The Calvert Cliffs Units 1 and 2 Technical Specification 3.5.5 will be revised as follows:

- Change the Technical Specification name from "Trisodium Phosphate (TSP)" to "Sodium Tetraborate (STB)".
- Change the Limiting Condition for Operation from "The TSP baskets shall contain ≥ 289.3 ft^3 of active TSP." to "The STB baskets shall contain ≥ 13,750 lbm of STB."
- Change Condition A and Required Action A.1 from "TSP" to "STB".
- Change Surveillance Requirement (SR) 3.5.5.1 from "Verify the TSP baskets contain ≥ 289.3 ft^3 of granular TSP dodecahydrate." to "Verify the STB baskets contain ≥ 13,750 lbm equivalent weight of sodium tetraborate decahydrate."
- Change SR 3.5.5.2 from "TSP baskets" to "STB baskets".
- Changes to the Table of Contents are proposed to reflect the new name of Technical Specification 3.5.5.

3.0 TECHNICAL EVALUATION

Background

Technical Specifications currently require the use of TSP as the buffering agent for the post-LOCA recirculation fluid. The TSP is stored in wire mesh baskets located on the containment floor at elevation 10'. Following the initiation of containment spray, boric acid solution from the refueling water tank with a pH of approximately 4 to 5 is sprayed into Containment. As this water collects on the containment floor the borated water dissolves the buffering agent. Mixing is achieved as the solution is continuously recirculated by the Emergency Core Cooling System (ECCS) pumps following a recirculation actuation signal. Trisodium phosphate is currently used as the buffering agent to increase the pH of the initially acidic post-LOCA containment sump water to a more neutral pH. The buffering agent ensures a minimum long-term equilibrium containment sump solution pH of ≥ 7.0. This provides for continued iodine retention effectiveness of the sump water and minimizes the occurrence of chloride and caustic induced stress corrosion cracking of systems and components exposed to the fluid.

Trisodium phosphate was initially selected as a post-LOCA buffering agent because of its favorable characteristics. In particular, it stores easily and the quantity needed to increase the coolant pH above 7.0 is reasonable. Post-LOCA buffering is mainly required to reduce the release of iodine fission products from the sump water to the containment atmosphere as iodine gas, in order to control the radiological

consequences (dose) of the accident. Maintaining a pH above 7.0 prevents significant amounts of iodine, released from fuel failures and dissolved in the recirculation water, from converting to a volatile form and evolving into the containment atmosphere. In addition to dose considerations, raising the pH in the post-LOCA containment pool to a value greater than 7.0 reduces the general corrosion rate of some structural materials and inhibits stress corrosion cracking in austenitic stainless steel.

The Pressurized Water Reactor Owners Group (PWROG) investigated the ability to reduce chemical precipitant formation simply by replacing TSP with another chemical that is less reactive with the materials in Containment in forming precipitants. The program tested alternative buffering agents to determine the efficacy of these materials to replace the TSP. The results of the PWROG activity were reported in WCAP-16596-NP (Reference 1). The results of the candidate buffer testing were used to determine the appropriate replacement for TSP and STB was selected as an acceptable alternative.

Proposed Change

The proposed change to Technical Specification 3.5.5, which replaces the use of TSP with STB, is consistent with the existing Technical Specification. Both buffer agents maintain pH control to ensure iodine retention and to minimize stress corrosion cracking in austenitic stainless steel. However, the use of TSP has been shown to potentially exacerbate post-LOCA sump screen blockage due to a potential adverse chemical interaction with certain calcium bearing materials used in Containment. Therefore, to preclude the potential for a possible adverse interaction, CCNPP is proposing to replace the TSP with the hydrated form of STB which has essentially the same buffering agent characteristics but with less potential adverse consequences. A fully hydrated form of STB is proposed which makes it less likely to absorb large amounts of water from the potentially humid containment conditions. If exposed to dry containment conditions, there is a potential for some loss of water. The chemical properties of the buffer do not change as the result of the potential water loss, but weight does decrease (Reference 1).

Additionally, we are requesting a change to the way the buffer agent is specified in the Technical Specifications. The standard Technical Specifications for Combustion Engineering plants (NUREG-1432) specifies a volume of buffer agent. We propose specifying a weight of buffer agent. The standard Technical Specification volume requires that it be derived from the required weight of the buffering agent assuming a density and purity of buffering agent. Density and purity of the buffering agent depend on the selected vendor. Since the actual measurement of STB will be accomplished by determining the volume of the buffer agent in the buffer baskets, the surveillance procedure will be changed to link the measured volume to the required weight using the density and purity of the material supplied by the vendor.

STB Mass Determination

Based on NUREG-0800, Section 6.5.2 (Reference 2), long-term iodine retention is assumed only when the equilibrium sump solution pH is above 7.0. An analysis has been performed to determine the amount of STB needed to maintain the post-LOCA containment sump solution pH $\geq$ 7.0 during recirculation (Attachment 3). The analysis considered the minimum and maximum quantities of boron and borated water and the time-dependent post-LOCA sump temperatures. In addition, the formation of acid from various sources including radiolysis of air and water, radiolysis of chloride bearing electrical cable insulation and jacketing, and spilled reactor core inventory were included. The pH of the sump pool was determined considering the rate of acid formation. A mass of 13,750 lbs of STB was determined to be the required amount to maintain an appropriate pH in the containment sump under post-LOCA conditions. This compares favorably with the existing mass of TSP (14,371 lbs TSP versus 13,750 lbs STB). The pH

values after the onset of recirculation and for 30 days (by which time the sump pool pH has reached an equilibrium value) are as follows:

	Minimum Sump Water	Maximum Sump Water
Initial pH	7.61	7.12
30 day pH	7.60	7.05

Based on the above, 13,750 lbm of STB is adequate to maintain the required pH range. This is the value that is proposed in the marked up Technical Specifications (Attachment 2).

STB Evaluation

Use of STB is predicted to result in a significant reduction in precipitate formation with no adverse side effects as demonstrated by the integrated chemical effects test (ICET) with TSP and STB (Reference 3), the results of the PWROG chemical effects testing (Reference 4), and alternate buffer testing documented in WCAP-16596-NP (Reference 1). Additionally:

- The STB will be contained in seismically qualified wire mesh baskets strategically located in the post-LOCA flooded region of the Containment. There are currently six wire mesh baskets in each Containment. Additional baskets will be added, if necessary, to contain the mass of STB.
- No new types of precipitates are formed in the target pH range of 7.0 to 8.0, which is within the range of the proposed pH control (Reference 1).
- Corrosion of steel structural material is comparable to that expected with TSP. Corrosion of submerged aluminum is higher with STB than with TSP for equivalent pH (Reference 1).
- STB is readily dissolved. STB is expected to form clumps due to local dissolution and re-precipitation under the in-service conditions of the containment environment. This phenomenon does not chemically change the STB portion of the material. Test results showed that relative to that of the granular form, the clumped STB took longer to dissolve as a result of the surface area reduction but nevertheless dissolved readily (Reference 1).
- The stability of STB in the containment environment can be considered comparable to or slightly better than TSP, a similar buffering agent which has been used extensively in pressurized water reactor (PWR) environments (Reference 1). The stability of STB to radiation exposure has been demonstrated to be satisfactory based on years of use in PWR environments.
- An assessment of the use of STB (Reference 1) has concluded that there are no adverse effects on the corrosion of zirconium-based alloys and stainless steel which are used in the fabrication of fuel assemblies and core components; therefore, replacement of the TSP containment buffer with STB is not expected to have any detrimental effects on the fuel.
- STB has been approved for use at PWRs (see Section 4.2).
- Minimal effects on environmental qualification (EQ) from the STB are expected based on an assessment of the existing EQ documentation. The change from TSP to STB is designed to minimize the impact on post-recirculation actuation signal containment spray pH conditions in Containment. In addition, chemical interaction between STB and exposed organic sub-components of EQ equipment is not expected to be significantly different than the interaction between TSP and exposed organic sub-components of EQ equipment.
- STB will provide additional dissolved boron for reactivity control.
- NUREG-0800 (References 2 and 5) sets a minimum pH of 7.0 for post-LOCA emergency coolant water to reduce the probability of stress corrosion cracking of austenitic stainless steel components, non-sensitized or sensitized, non-stressed or stressed. Replacing the TSP buffering agent with STB

would not increase the potential for stress corrosion cracking because the STB would ensure that a pH of ≥ 7.0 is maintained during recirculation.

Application of the WCAP-16530-NP (Reference 4) chemical model for Calvert Cliffs specific conditions predicts that under LOCA conditions, sodium aluminum silicate ($NaAlSi_3O_8$) will form as precipitate using either TSP or STB. No aluminum oxyhydroxide (AlOOH) is formed with either TSP or STB. Under the same conditions, an additional 53.79 kg of calcium phosphate [$Ca_3(PO_4)_2$] precipitate could be generated using TSP compared to no calcium phosphate formation using STB. The following table provides a summary of the predicted precipitate generation. The values presented here may not represent the final conditions credited for Calvert Cliffs, however, they present a comparison of the differences associated with the two buffering agents.

Predicted Chemical Precipitate Formation for Calvert Cliffs

Generated Precipitates	Buffering Agent	
	TSP	STB
$NaAlSi_3O_8$ (kg)	28.34	29.70
AlOOH (kg)	0	0
$Ca_3(PO_4)_2$ (kg)	53.79	0
Total (kg)	82.13	29.70

Thus, the change of buffering agent from TSP to STB is expected to eliminate the calcium phosphate precipitate resulting in a decrease of approximately 64% in the quantity of precipitate generated.

Conclusion

Calvert Cliffs has determined that STB is an acceptable alternative to TSP based on industry testing of buffers outlined in WCAP-16596-NP (Reference 1) and through plant-specific application of the chemical model developed in WCAP-16530-NP (Reference 4), as modified. In addition, CCNPP has determined that in order to maintain a sump pH of ≥ 7.0 a minimum mass of STB of ≥ 13,750 lbm is required. A minimum sump pH of 7.0 prevents significant amounts of iodine, released from failed fuel and dissolved in the recirculation water, from converting to a volatile form and evolving into the containment atmosphere. The proposed amendment does not affect the dose analyses, as the initial condition of reducing the amount of re-evolving iodine is achieved by maintaining a sump pH of ≥ 7.0. Therefore, 10 CFR 50.67 limits during a LOCA would not be exceeded.

4.0 REGULATORY ANALYSIS

4.1 Applicable Regulatory Requirements/Criteria

10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors"

The containment sump (also known as the emergency recirculation sump) is part of the ECCS. Every nuclear power plant is required by 10 CFR 50.46, to have an ECCS to mitigate a design-basis accident. Paragraph 10 CFR 50.46(a)(1)(i) states, in part, that each "pressurized light-water nuclear power reactor … must be provided with an [ECCS] that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents [LOCA] conforms to the criteria set forth in paragraph (b) of this section," 10 CFR 50.46(b)(5), "Long-term cooling," states, "[a]fter any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core."

10 CFR 50.49, Environmental Qualification of Electrical Equipment Important to Safety

Replacing TSP with STB, as a buffering agent for containment sump pH control, is expected to have minimal impact on environmental qualification by maintaining the same pH range as the existing buffering agent.

10 CFR 50.67, Accident Source Term and 10 CFR Part 100, Reactor Site Criteria

The proposed amendment does not affect the dose analyses, as the initial condition of reducing the amount of re-evolving iodine is achieved by maintaining a sump pH of ≥ 7.0. Therefore, 10 CFR 50.67 limits during a LOCA would not be exceeded.

4.2 Precedent

Palisades, Arkansas Nuclear One-2 and Indian Point Unit 2 have submitted license amendment requests to change their containment buffer agents from TSP to STB. These requests were approved by the Nuclear Regulatory Commission as shown below.

Palisades submitted a license amendment request by letter dated June 29, 2007 that was approved by letter dated October 2, 2007.

Arkansas Nuclear One-2 submitted a license amendment request by letter dated October 5, 2007 that was approved by letter dated March 31, 2008.

Indian Point Unit 2 submitted a license amendment request by letter dated October 24, 2007, that was approved by letter dated February 7, 2008.

4.3 Significant Hazards Consideration

Calvert Cliffs Nuclear Power Plant (CCNPP) intends to replace trisodium phosphate (TSP) as the buffering agent for pH control during recirculation with sodium tetraborate (STB). The purpose of this change is to minimize the potential for sump screen blockage concerns under post-LOCA conditions due to a potential adverse chemical interaction between TSP and certain materials used in Containment. The use of TSP ensures a neutral pH for the solution recirculated in the containment sump. The neutral pH minimizes the evolution of iodine and minimizes the occurrence of stress corrosion on mechanical systems and components exposed to the fluid. The proposed use of STB serves this same function, maintaining the intent of the Technical Specification, but results in less predicted precipitate generation and resultant sump screen blockage.

Calvert Cliffs has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by assessing the change using the three criteria of 10 CFR 50.92 as discussed below:

1. *Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?*

   Response – No

   The proposed amendment does not involve a significant increase in the probability of an accident previously evaluated because the containment buffering agent is not an initiator of any analyzed accident. The proposed change does not impact any failure modes that could lead to an accident. The proposed amendment does not involve a significant increase in the consequences of an accident

previously evaluated. The buffering agent in Containment is designed to buffer the acids expected to be produced after a loss-of-coolant accident (LOCA) and is credited in the radiological analysis for iodine retention. Utilizing the required quantity of sodium tetraborate decahydrate (STB) as a buffering agent ensures the post-LOCA containment sump mixture will have a pH ≥ 7.0. The proposed change of replacing trisodium phosphate (TSP) with STB results in the radiological consequences remaining within the limits of 10 CFR 50.67. There is no dose change with the pH ≥ 7.0.

Therefore, operation of the facility in accordance with the proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?*

Response – No

The proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated. The STB is a passive component that is proposed to be used as a buffering agent to increase the pH of the initially acidic post-LOCA containment water to a more neutral pH. Changing the proposed buffering agent from TSP to STB does not constitute an accident initiator or create a new or different kind of accident than previously analyzed. The proposed amendment does not involve operation of any required systems, structures, or components in a manner or configuration different from those previously recognized or evaluated. No new failure mechanisms will be introduced by the changes being requested. Therefore, the proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the proposed change involve a significant reduction in a margin of safety?*

Response – No

The proposed amendment does not involve a significant reduction in a margin of safety. The proposed amendment of changing the buffering agent from TSP to STB results in equivalent control of maintaining sump pH at ≥ 7.0, thereby controlling containment atmosphere iodine and ensuring the radiological consequences of a LOCA are within regulatory limits. The change of buffering agent from TSP to STB also reduces the amount of calcium phosphate precipitate generated thereby reducing the overall amount of precipitate that may be formed in a postulated LOCA. The buffer change would minimize the potential chemical effects and should enhance the ability of the Emergency Core Cooling System to perform the post-LOCA mitigating functions.

Therefore, the proposed amendment does not involve a significant reduction in the margin of safety.

5.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed change would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR Part 20, or would change an inspection or surveillance requirement. However, the proposed change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR

51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

1. WCAP-16596-NP, "Evaluation of Alternative Emergency Core Cooling System Buffering Agents," Revision 0, July 2006
2. NUREG-0800, "Standard Review Plan," Section 6.5.2, "Containment Spray as a Fission Product Cleanup System," Revision 4, dated March 2007
3. LA-UR-05-9177, "Integrated Chemical Effects Test Project: Test #5 Data Report," January 2006
4. WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," Revision 0, as modified by Westinghouse errata letters WOG-06-102, WOG-06-232, WOG-06-273, and the responses to the NRC Requests for Additional Information (RAI) in WOG-06-387
5. Branch Technical Position 6-1 "pH For Emergency Coolant Water for Pressurized Water Reactors" Revision 0, dated March 2007