Omaha Public Power District

444 South 16th Street Mall
Omaha NE 68102-2247

September 11, 2007
LIC-07-0082

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

References:
1. Docket No. 50-285
2. Fort Calhoun Station, Unit No. 1, License Amendment Request "Change of Containment Building Sump Buffering Agent from Trisodium Phosphate to Sodium Tetraborate" dated August 21, 2006 (LIC-06-0088) (ML062340039)
3. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure), "Fort Calhoun Station, Unit No. 1 – Issuance of Amendment 247 Re: Change of Containment Building Sump Buffering Agent from Trisodium Phosphate to Sodium Tetraborate (TAC No. MD2864)," dated November 13, 2006 (NRC-06-0155) (ML063120248)
4. LTR-CDME-06-115-NP, Rev. 1, "Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station," Revision 1, dated November 15, 2006

SUBJECT: Fort Calhoun Station, Unit No. 1, License Amendment Request (LAR) "Permanent Use of Sodium Tetraborate as the Containment Building Sump Buffering Agent"

Pursuant to 10 CFR 50.90, the Omaha Public Power District (OPPD) hereby requests an amendment to the Fort Calhoun Station, Unit No. 1, (FCS) Technical Specifications (TS).

The proposed changes remove the footnote to TS 2.3(4) and TS 3.6(2)d indicating that the use of sodium tetraborate (NaTB) is approved for Fuel Cycle 24 only (Reference 3). In addition, TS 2.3, Figure 2-3 is revised to increase the volume of NaTB required. The increased volume of NaTB reflects a decrease in the density of NaTB due to the selection of a different vendor and an increase in mass to provide additional pH control margin. Revision 0 of Reference 4 was attached to OPPD's previous License Amendment Request (Reference 2). Reference 4 has since been revised and thus to facilitate NRC review, OPPD is attaching Reference 4 along with an Addendum thereto. The Addendum to Reference 4 is the basis for revising the volume, density, and mass of NaTB.

Changes to the Basis of TS 3.6 are provided for information only and will be processed in accordance with the Technical Specification Bases Control Program of TS 5.20 to ensure that surveillance testing supports the revised parameters.

Attachment 1 provides OPPD's evaluation of the proposed amendment. Attachment 2 provides the existing TS pages marked-up to show the proposed changes. Attachment 3 provides the proposed TS pages with the changes incorporated. Attachment 4 provides a copy of Reference 4. Attachment 5 provides a copy of the Addendum to Reference 4.

OPPD respectfully requests NRC approval by April 1, 2008 and will implement the Amendment and associated TS 3.6 Basis changes prior to plant startup from the 2008 Refueling Outage scheduled to begin April 19, 2008.

If you have additional questions, or require further information, please contact Mr. Thomas C. Matthews at (402) 533-6938.

No commitments to the NRC are made in this letter.

I declare under penalty of perjury that the forgoing is true and correct. Executed on September 11, 2007.

R. P. Clemens
Division Manager – Nuclear Engineering

MLE/mle

Attachments:

1. OPPD Evaluation of the Proposed Changes
2. Proposed Technical Specification Changes (Markup)
3. Revised Technical Specification Pages (Clean)
4. LTR-CDME-06-115-NP, Rev. 1
5. Addendum to LTR-CDME-06-115-NP, Rev. 1

c: Director of Consumer Health Services, Department of Regulation and Licensure, Nebraska Health and Human Services, State of Nebraska

ATTACHMENT 1

Omaha Public Power District
Evaluation of the Proposed Changes

1.0 SUMMARY DESCRIPTION

The Omaha Public Power District (OPPD) is submitting this license amendment request (LAR) to revise Fort Calhoun Station, Unit No. 1, (FCS) Renewed Facility Operating License No. DPR-40. The proposed changes revise Technical Specifications (TS) 2.3(4), "Containment Sump Buffering Agent Specification and Volume Requirement," and TS 3.6 "Surveillance Requirements" to allow the permanent use of sodium tetraborate (NaTB) as the containment sump buffering agent. In August 2006, OPPD submitted a LAR (Reference 5) to replace trisodium phosphate (TSP) with NaTB. Based on discussions with the NRC at the time, OPPD limited the duration of the use of NaTB to Fuel Cycle 24 to facilitate NRC approval. The NRC approved the Reference 5 LAR in Amendment 247 (Reference 9).

OPPD requests that previously approved TS changes be made permanent and applicable to subsequent operating cycles. Thus, the proposed changes consist of removing the footnote in TS 2.3(4) and TS 3.6(2)d limiting the applicability of those specifications to Fuel Cycle 24. In addition, OPPD is revising TS 2.3, Figure 2-3 to reflect an increase in the minimum required buffer volume. The new volume reflects a change in buffer density due to the selection of a new vendor and an increase in the mass of buffer to ensure that final pH is slightly greater than 7.0.

2.0 DETAILED DESCRIPTION

The proposed amendment permanently changes the containment sump buffering agent specification from TSP to NaTB. The footnotes of TS 2.3(4) and TS 3.6(2)d stating, "This specification is applicable only for Fuel Cycle 24" are deleted. Figure 2-3 is revised to reflect a new minimum volume required to achieve a post-LOCA sump pH of ≥ 7.0. The revised figure reflects a lower density of NaTB due to a change in the vendor and an increase in the mass of buffer to ensure that the resulting post-LOCA sump pH is slightly greater than 7.0.

The Basis of TS 3.6 is revised to reflect the changed volume, density, mass and corresponding sample size used in the surveillance test. The TS 3.6 Basis changes are provided for information only and will be processed in accordance with the FCS TS Bases Change (TSBC) control program following NRC approval of the requested amendment.

3.0 TECHNICAL EVALUATION

3.1 System Description

Under loss-of-coolant accident (LOCA) conditions, buffering agents are added to the emergency core cooling system (ECCS) to increase the coolant pH to ≥ 7.0. At FCS, the buffering agent is stored in baskets that become submerged within the containment sump pool (as the post-LOCA water level rises) and release the buffering agent by dissolution. Buffering agent addition is mainly required to reduce the release of iodine fission products from the coolant to the containment atmosphere as iodine gas. Thus, pH control is primarily a measure of controlling offsite dose. An additional benefit is that maintaining pH $\geq$ 7.0 reduces general corrosion of structural materials in containment, particularly aluminum and carbon/low alloy steels. It also reduces the potential for localized attack of austenitic stainless steel components by aggressive species such as chlorides (e.g., chloride induced stress corrosion cracking).

3.2 Results Justifying the Amendment and Technical Details Supporting Safety Arguments

In 2006, following NRC approval of Amendment 247, OPPD changed the containment sump buffer from TSP to NaTB as part of the modifications implemented in response to Generic Letter 2004-02. Because the use of NaTB was limited to Fuel Cycle 24, the NRC noted in the safety evaluation report that it did not perform a detailed review of the OPPD reference material that developed the threshold amount of dissolved calcium needed to form a precipitate in NaTB and that a more detailed review would be necessary for a permanent change. The subject reference material (Reference 4) was provided in the LAR (Reference 5) and in several letters (References 6 and 8) sent in response to NRC requests for additional information (Reference 7).

Following the issuance of Amendment 247, the NRC noted in an email to the Nuclear Energy Institute (Reference 10) that license amendment requests for buffer replacement should demonstrate reduced chemical effects. As noted in Reference 10, the technical basis for chemical effects that demonstrates acceptable head loss will be evaluated as part of the Generic Safety Issue (GSI)-191 resolution process and not as part of the buffer amendment process. In Reference 8, OPPD provided electronic copies of the Pressurized Water Reactor (PWR) Owners Group (PWROG) chemical model spreadsheet for FCS showing a reduction in precipitate formation with NaTB in comparison to TSP.

In addition to reduced chemical effects, Reference 10 stated that licensees must show that pH is maintained $\geq$ 7.0 for the staff to conclude that existing assumptions regarding iodine levels in the containment atmosphere remain valid. In Reference 5, OPPD demonstrated that NaTB will maintain the pH of the sump pool $\geq$ 7.0. NaTB has a long operating history as a buffering agent at U.S. ice condenser PWRs and the evaluation of Reference 5 supports the long-term use of this chemical at FCS as well.

Because of its extensive operating history and with projected pH $\geq$ 7.0, no review/consideration of corrosion and stress corrosion cracking is necessary for NaTB (Reference 10). The use of NaTB at FCS does not introduce any corrosion and/or stress corrosion cracking issues not previously considered at ice condenser PWRs. The NaTB delivery system at FCS uses baskets on the containment floor, whereas ice condenser PWRs mix the NaTB in ice. The FCS design configuration therefore does not introduce any delays in delivering NaTB into the sump pool. Long-term use of NaTB does not change the design function of the buffering agent storage baskets located in the containment sump.

Finally, Reference 10 requested licensees to verify that equipment subject to environmental qualification (EQ) remains within the analyzed EQ envelope in the presence of the proposed buffer. In developing Reference 5, the effects of NaTB on the EQ envelope were evaluated. It was determined that the electrical equipment qualification (EEQ) of components inside containment was not affected by the replacement of TSP with NaTB as the buffering properties of TSP and NaTB are the same (Reference 5). This conclusion remains valid with the revised NaTB parameters reflected in the proposed revisions to TS 2.3, Figure 2-3 and to the Basis of TS 3.6. Reference 11 shows that the revised NaTB parameters result in a minimum sump pH of 7.05, which is only slightly greater than that obtained previously but remains well below the EEQ analyzed limit of 8.0.

In summary, OPPD has previously evaluated (Reference 5) the use of NaTB based on References 3 and 4 and has determined that NaTB is suitable for long-term operation at FCS. These previous evaluations remain valid and supportive of a permanent change to NaTB as they show that NaTB reduces precipitant formation by eliminating the chemical reaction between the buffer and calcium silicate insulation. Since NaTB is already approved for long-term use at ice condenser PWRs, the long-term use of NaTB at FCS does not result in any unknown adverse environmental effects.

3.3 Design Basis

The changes to TS 2.3(4) and TS 3.6(2)d delete the footnote limiting their applicability to Fuel Cycle 24 and allow long-term use of NaTB, which is consistent with the intent of NUREG-1432, Rev. 3, "Standard Technical Specifications Combustion Engineering Plants," (Reference 2). NaTB has essentially the same buffering agent characteristics as TSP with considerably less chemical interactions that can result in containment sump strainer plugging.

TS 2.3(4), Figure 2-3 shows the minimum required volume of buffering agent as Hot Zero Power (HZP), Critical Boron Concentration (CBC) decreases over the operating cycle. The volume of NaTB required by Figure 2-3 will be increased to allow the use of lower density NaTB from a new vendor. The revised volume also reflects an increase in the mass of NaTB to provide a slight increase in pH control margin with minimal impact on EEQ margin. The proposed changes ensure that the post-LOCA containment sump pH is ≥ 7.0, the proposed changes are bounding for all operating parameters, and thus the proposed changes are suitable for long-term operation.

The Basis of TS 3.6 is revised to account for the increased volume of NaTB required by Figure 2-3. Since the NaTB density is lower, the Basis of TS 3.6 is revised to incorporate the corresponding mass and volume increase necessary to achieve containment sump pH ≥ 7.0. Consequently, the size of the NaTB sample from the sump used to measure buffering ability was also increased slightly. The increased mass and volume of NaTB required when FCS is in Operating Modes 1 and 2 was determined using the same methodology used to evaluate the use of NaTB in Reference 4, provided as an attachment to Reference 5. The TS 3.6 Basis changes are provided for information only and will be processed in accordance with the FCS TSBC control program following NRC approval of the requested amendment.

The changes to TS 2.3(4), Figure 2-3, and the Basis of TS 3.6 require a volume of NaTB sufficient to neutralize all sources of borated water and acids formed from post-LOCA degradation of electrical cable jackets and radiolysis of air. As part of the FCS core reload analysis process, OPPD will continue to verify NaTB volume for all future operating cycles based on HZP CBC limits. Thus, the proposed changes meet regulatory and FCS design basis requirements for long-term plant operation.

3.4 Risk Information

The scope, level of detail, and technical methods of the calculations and the associated engineering evaluation, conducted to justify the proposed TS changes, reflect configuration and operating experience at FCS as previously detailed in Reference 5. A risk-informed approach with the use of probabilistic risk assessment or sensitivity study was not considered in this determination.

In conclusion, based on the above discussion,

(1) There is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner,

(2) Such activities will be conducted in compliance with the Commission's regulations, and

(3) The issuance of the amendment will not be inimical to the common defense and security of the health and safety of the public.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

The previous changes to TS 2.3(4) and its associated Basis section approved by Amendment 247 allowing the temporary use of NaTB are consistent with the applicable regulatory requirement in NUREG 0800, Section 6.5.2, "Containment Spray as a Fission Product Cleanup System" and suitable for long-term operation. Subsection 11.1.g specifies that the pH of all solutions in the containment sump and all additives for reactivity control, fission product removal, or other purposes (boric acid) should be maintained at a level high enough to assure that significant long-term iodine re-evolution does not occur. Long-term iodine retention may be assumed only when the equilibrium post-LOCA sump pH, after mixing and dilution with primary coolant and ECCS injection sources (safety injection refueling water tank, safety injection tanks, and boric acid storage tanks), is ≥ 7.0.

The scope of the proposed amendment is limited to (1) removing the restriction limiting NaTB to Fuel Cycle 24 and (2) an increase in the volume of NaTB required to assure post-LOCA sump pH is ≥ 7.0. Corresponding changes to the Basis of TS 3.6 are provided for information only and will be processed in accordance with the FCS TSBC control program to ensure that surveillance testing adequately verifies both the volume of NaTB and its buffering ability. The Basis changes will be incorporated following NRC approval of the requested amendment.

No other regulatory requirements or guidance applicable to the proposed TS changes was identified.

4.2 Precedent

NaTB is already in use at ice condenser plants (Reference 1) and has a long and acceptable history. Long-term utilization of NaTB in place of TSP as a buffering agent at FCS serves an analogous function to its use in ice condenser plants, albeit via a different delivery mechanism (dissolution of granular NaTB versus melting NaTB ice).

4.3 Significant Hazards Consideration

The Omaha Public Power District (OPPD) proposes to revise Technical Specifications (TS) 2.3(4), "Containment Sump Buffering Agent Specification and Volume Requirement" and TS 3.6 "Surveillance Requirements." OPPD previously submitted and received NRC approval of a change to these TS applicable only for Fuel Cycle 24. OPPD requests approval of the proposed TS changes on a permanent basis applicable to subsequent operating cycles. The change to TS 2.3(4) and TS 3.6 consist of removing a footnote stating that the changes are applicable only for Fuel Cycle 24. In addition, TS 2.3, Figure 2-3 is revised to increase the minimum required buffer volume. The new volume reflects a lower density NaTB buffer from a new vendor and an increase in the mass of buffer sufficient to provide a slight increase in pH control margin. Corresponding changes to the Basis of TS 3.6 are provided for information only and will be processed in accordance with the Fort Calhoun Station Technical Specification Bases Change (TSBC) control program following NRC approval of the requested amendment.

OPPD has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of Amendment," as discussed below:

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

   Response: No

   There are no changes to the design or operation of the plant affecting structures, systems, and components (SSCs) or accident functions due to long-term use of sodium tetraborate (NaTB). Similarly, there are no changes to the design or operation of the plant affecting SSCs or accident functions because of revising the volume of buffering agent required during Operating Modes 1 and 2. The changes are necessary due to the lower density of NaTB that will be obtained from a new vendor and provide for additional pH control margin in the post loss-of-coolant accident (LOCA) sump with minimal impact on electrical equipment qualification (EEQ) margin.

All SSCs function as designed and the performance requirements have been evaluated and found to be acceptable. NaTB will maintain pH $\geq$ 7.0 in the recirculation water following a LOCA. This function is maintained with the proposed change.

Analysis demonstrates that using NaTB as a buffering agent ensures the post-LOCA containment sump mixture will have a pH $\geq$ 7.0. The buffering agent is not an accident initiator; therefore, the use of NaTB on a permanent basis will 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

   No new accident scenarios, failure mechanisms, or single failures are introduced because of the proposed changes. All SSCs previously required for mitigation of an event remain capable of fulfilling their intended design function. The proposed changes have no adverse effects on any safety-related system or component and do not challenge the performance or integrity of any safety related system. The long-term use of NaTB as a buffering agent has been evaluated and no new accident scenarios or single failures are introduced.

   Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any previously evaluated.

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

   Response: No

   Removing the restrictions limiting the use of NaTB to Fuel Cycle 24 to allow long-term operation with NaTB does not affect its capability to maintain the pH of the containment sump $\geq$ 7.0 post-LOCA. Previous evaluations have shown that NaTB is capable of maintaining the pH of the containment sump $\geq$ 7.0 post-LOCA. A volume of NaTB that is dependent on hot zero power critical boron concentration has been evaluated previously with respect to neutralization of all borated water and acid sources. These evaluations concluded that there would be no impact on pH control, and hence no reduction in the margin of safety related to post-LOCA conditions.

Therefore, the proposed changes do not involve a significant reduction in a margin of safety.

4.4 Conclusion

Operation of Fort Calhoun Station, Unit No.1, in accordance with the proposed amendment will not result in a significant increase in the probability or consequences of any accident previously analyzed; will not result in a new or different kind of accident previously analyzed; and does not result in a significant reduction in a margin of safety. Based on the above, OPPD concludes that the proposed amendment to allow permanent use of NaTB as the buffering agent in the containment sump presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

5.0 ENVIRONMENTAL CONSIDERATION

Based on the above considerations, the proposed amendment 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. NUREG-1431, Rev. 3.0, Volume 2, "Standard Technical Specifications Westinghouse Plants," dated June 2004

2. NUREG-1432, Rev. 3.0, Volume 2, "Standard Technical Specifications Combustion Engineering Plants," dated June 2004

3. WCAP-16530-NP, Rev. 0, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," dated February 2006 (ML060890509)

4. LTR-CDME-06-115-NP, Rev. 0, "Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station," dated August 15, 2006

5. Fort Calhoun Station, Unit No. 1 License Amendment Request "Change of Containment Building Sump Buffering Agent from Trisodium Phosphate to Sodium Tetraborate," dated August 21, 2006 (LIC-06-0088) (ML062340039)

6. Letter from OPPD (J. A. Reinhart) to NRC (Document Control Desk), "Response to Request for Additional Information Related to the License Amendment Request on Change of Containment Sump Buffering Agent from Trisodium Phosphate to Sodium Tetraborate," dated September 6, 2007 (LIC-06-0105) (ML062570173)

7. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure), "Fort Calhoun Station, Unit No. 1 Request for Additional Information Related to the Replacement of Trisodium Phosphate (TAC No. M02864)," dated October 4, 2006 (NRC-06-0136) (ML062760502)

8. Letter from OPPD (J. A. Reinhart) to NRC (Document Control Desk), "Response to Request for Additional Information (RAI) Related to the Replacement of Trisodium Phosphate," dated October 10, 2006 (LIC-06-0116) (ML062860428)

9. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure), "Fort Calhoun Station, Unit No. 1 – Issuance of Amendment 247 Re: Change of Containment Building Sump Buffering Agent from Trisodium Phosphate to Sodium Tetraborate (TAC No. MD2864)," dated November 13, 2006 (NRC-06-0155) (ML063120248)

10. NRC Staff Review Plans for Buffer Replacement Amendments, dated March 29, 2007 (ML071280350)

11. Letter from Westinghouse (K. M. Rajan) to OPPD (J. Gasper) "Additional Testing of Sodium Tetraborate Buffer, Transmittal of Addendum to LTR-CDME-06-115-NP," dated September 6, 2007 (CFTC-07-37)

Proposed Technical Specification Changes (Markup)

2.0 **LIMITING CONDITIONS FOR OPERATION**
2.3 Emergency Core Cooling System (Continued)

(3) Protection Against Low Temperature Overpressurization

The following limiting conditions shall be applied during scheduled heatups and cooldowns. Disabling of the HPSI pumps need not be required if the RCS is vented through at least a 0.94 square inch or larger vent.

Whenever the reactor coolant system cold leg temperature is below 350°F, at least one (1) HPSI pump shall be disabled.

Whenever the reactor coolant system cold leg temperature is below 320°F, at least two (2) HPSI pumps shall be disabled.

Whenever the reactor coolant system cold leg temperature is below 270°F, all three (3) HPSI pumps shall be disabled.

In the event that no charging pumps are operable when the reactor coolant system cold leg temperature is below 270°F, a single HPSI pump may be made operable and utilized for boric acid injection to the core, with flow rate restricted to no greater than 120 gpm.

(4) Containment Sump Buffering Agent Specification and Volume Requirement*

During operating Modes 1 and 2, the containment sump buffering agent baskets shall contain a volume of hydrated sodium tetraborate (NaTB) that is within the area of acceptable operation shown in Figure 2-3.

a. With the above buffering agent requirements not within limits, the buffering agent shall be restored within 72 hours.

b. With Specification 2.3(4)a required action and completion time not met, the plant shall be in hot shutdown within the next 6 hours and cold shutdown within the following 36 hours.

Basis

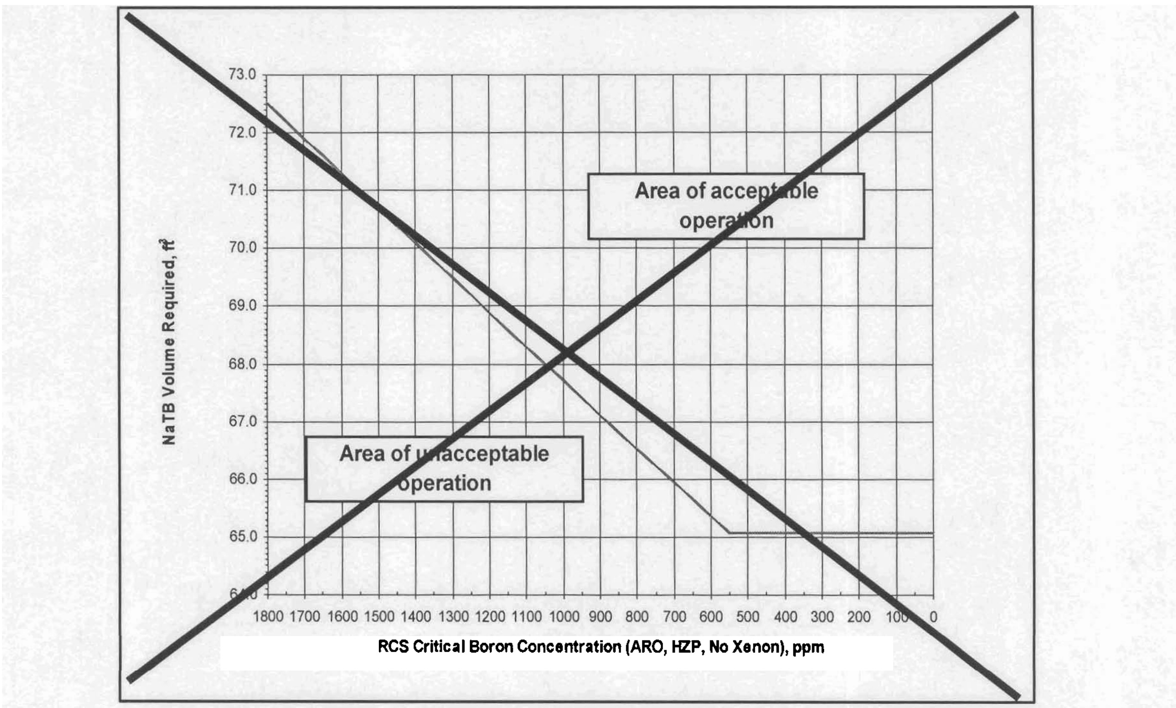
The normal procedure for starting the reactor is to first heat the reactor coolant to near operating temperature by running the reactor coolant pumps. The reactor is then made critical. The energy stored in the reactor coolant during the approach to criticality is substantially equal to that during power operation and therefore all engineered safety features and auxiliary cooling systems are required to be fully operable.

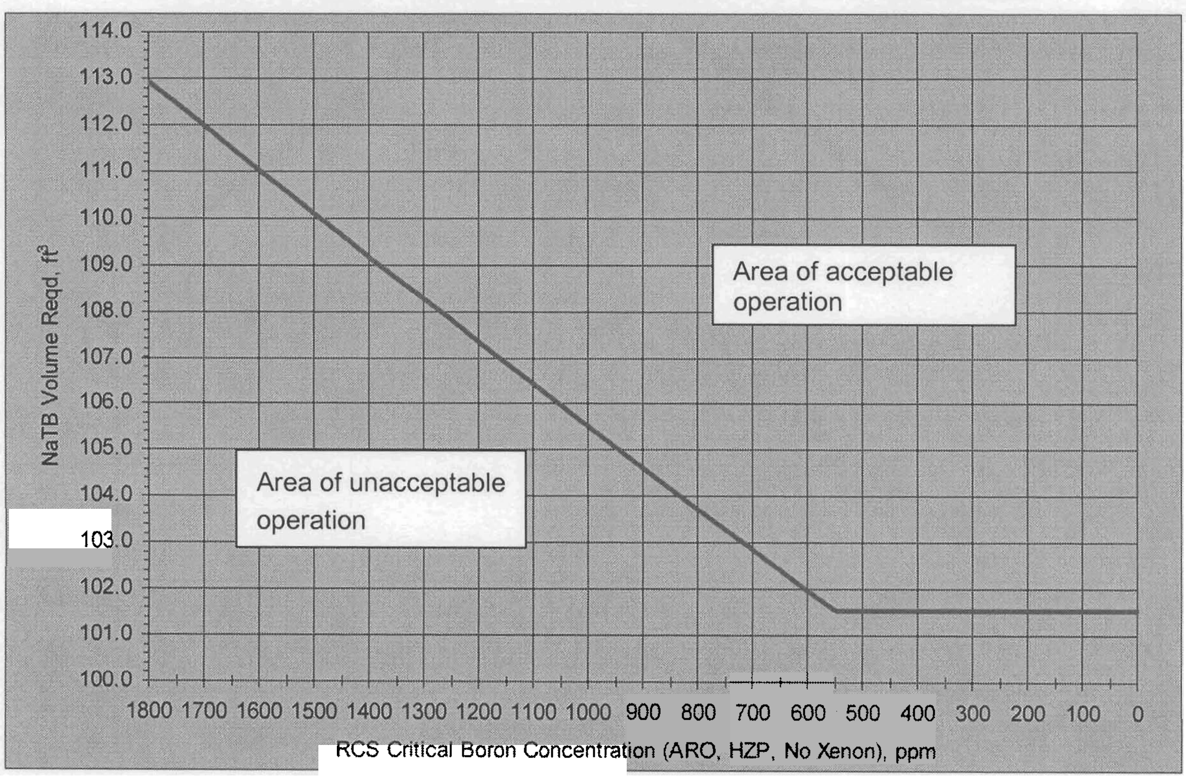
~~* This specification is applicable only for Fuel Cycle 24~~

2.0 **LIMITING CONDITIONS FOR OPERATION**

2.3 Emergency Core Cooling System (Continued)

Figure 2-3
NaTB Volume Required for RCS Critical Boron Concentration (ARO, HZP, No Xenon)





3.0 **SURVEILLANCE REQUIREMENTS**

3.6 Safety Injection and Containment Cooling Systems Tests

Applicability

Applies to the safety injection system, the containment spray system, the containment cooling system and air filtration system inside the containment.

Objective

To verify that the subject systems will respond promptly and perform their intended functions, if required.

Specifications

(1) Safety Injection System

System tests shall be performed on a refueling frequency. A test safety feature actuation signal will be applied to initiate operation of the system. The safety injection and shutdown cooling system pump motors may be de-energized for this portion of the test.

A second overlapping test will be considered satisfactory if control board indication and visual observations indicate all components have received the safety feature actuation signal in the proper sequence and timing (i.e., the appropriate pump breakers shall have opened and closed, and all valves shall have completed their travel).

(2) Containment Spray System

a. System tests shall be performed on a refueling frequency. The test shall be performed with the isolation valves in the spray supply lines at the containment blocked closed. Operation of the system is initiated by tripping the normal actuation instrumentation.

b. At least every ten years the spray nozzles shall be verified to be open.

c. The test will be considered satisfactory if:

(i) Visual observations indicate that at least 264 nozzles per spray header have operated satisfactorily.

(ii) No more than one nozzle per spray header is missing.

d.~~*~~ Representative samples of Hydrated Sodium Tetraborate (NaTB) that have been exposed to the same environmental conditions as that in the mesh baskets shall be tested on a refueling frequency by:

~~*This Specification is applicable only for Fuel Cycle 24.~~

3.0 SURVEILLANCE REQUIREMENTS

3.6 Safety Injection and Containment Cooling Systems Tests (Continued)

Operation of the system for 10 hours every month will demonstrate operability of the filters and adsorbers system and remove excessive moisture build-up on the adsorbers.

Demonstration of the automatic initiation capability will assure system availability.

Determination of the volume of buffering agent in containment must be performed due to the possibility of leaking valves and components in the containment building that could cause dissolution of the buffering agent during normal operation.

A refueling frequency shall be utilized to visually determine that the volume of buffering agent contained in the buffering agent baskets is within the area of acceptable operation based on the buffering agent volume required by Figure 2-3. A measured value or the Technical Data Book (TDB) II, "Reactivity Curves" may be used to obtain a hot zero power (HZP) critical boron concentration (CBC). The "as found" volume of buffering agent must be within the area of acceptable operation of Figure 2-3 using this HZP CBC value. Prior to exiting the refueling outage, visual buffering agent volume determination is performed to ensure that the "as-left" volume of buffering agent contained in the baskets is ≥ 112.9 ~~72.5~~ ft^3. This requirement ensures that there is an adequate quantity of buffering agent to adjust the pH of the post-LOCA sump solution to a value ≥ 7.0 for HZP CBC up to 1800 ppm.

Testing must be performed to ensure the solubility and buffering ability of the NaTB after exposure to the containment environment. A representative sample of 1.39 ~~1.24~~ to 1.42 ~~1.27~~ grams of NaTB from one of the baskets in containment is submerged in 0.99 – 1.01 liters of water at a boron concentration of 2436 – 2456 ppm (equivalent to a RCS boron concentration of 1800 ppm - Figure 2-3) using boric acid. At a standard temperature of 115 – 125°F, without agitation, the solution must be left to stand for 4 hours. The liquid is then decanted and mixed, the temperature is adjusted to 75 – 79°F and the pH measured. At this point, the pH must be ≥ 7.0. The representative sample weight is based on the minimum required NaTB weight of 5418 ~~4301~~ pounds, less the quantity required to account for acidic radiolysis products (758 pounds), and maximum possible post-LOCA sump volume of 398,445 gallons, normalized to a 1.0 liter sample. At a manufactured density of 48.0 ~~59.3~~ lb_m/ft^3, 5418 ~~4301~~ pounds corresponds to the minimum volume of 112.9 ~~72.5~~ ft^3.

For dissolution testing, the boron concentration of the test water is representative of the maximum possible boron concentration corresponding to the maximum possible post-LOCA sump volume. The post-LOCA sump volume originates from the Reactor Coolant System (RCS), the Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. The cumulative boron concentration is based on a maximum RCS HZP CBC with no Xenon at Beginning of Cycle conditions, SIRWT and SIT boron concentrations at maximum allowed values of 2,350 ppm and maximum BAST concentration of 4.5 % wt. Agitation of the test solution is prohibited since an adequate standard for the agitation intensity cannot be specified. The test time of 4 hours is necessary to allow time for the dissolved NaTB to naturally diffuse through the sample solution. In the post-LOCA containment sump, rapid mixing would occur, significantly decreasing the actual amount of time before the required pH is achieved. This would ensure achieving a pH ≥ 7.0 by the onset of recirculation after a LOCA.

Revised Technical Specification Pages (Clean)

2.0 **LIMITING CONDITIONS FOR OPERATION**
2.3 Emergency Core Cooling System (Continued)

(3) Protection Against Low Temperature Overpressurization

The following limiting conditions shall be applied during scheduled heatups and cooldowns. Disabling of the HPSI pumps need not be required if the RCS is vented through at least a 0.94 square inch or larger vent.

Whenever the reactor coolant system cold leg temperature is below 350°F, at least one (1) HPSI pump shall be disabled.

Whenever the reactor coolant system cold leg temperature is below 320°F, at least two (2) HPSI pumps shall be disabled.

Whenever the reactor coolant system cold leg temperature is below 270°F, all three (3) HPSI pumps shall be disabled.

In the event that no charging pumps are operable when the reactor coolant system cold leg temperature is below 270°F, a single HPSI pump may be made operable and utilized for boric acid injection to the core, with flow rate restricted to no greater than 120 gpm.

(4) Containment Sump Buffering Agent Specification and Volume Requirement

During operating Modes 1 and 2, the containment sump buffering agent baskets shall contain a volume of hydrated sodium tetraborate (NaTB) that is within the area of acceptable operation shown in Figure 2-3.

a. With the above buffering agent requirements not within limits, the buffering agent shall be restored within 72 hours.

b. With Specification 2.3(4)a required action and completion time not met, the plant shall be in hot shutdown within the next 6 hours and cold shutdown within the following 36 hours.

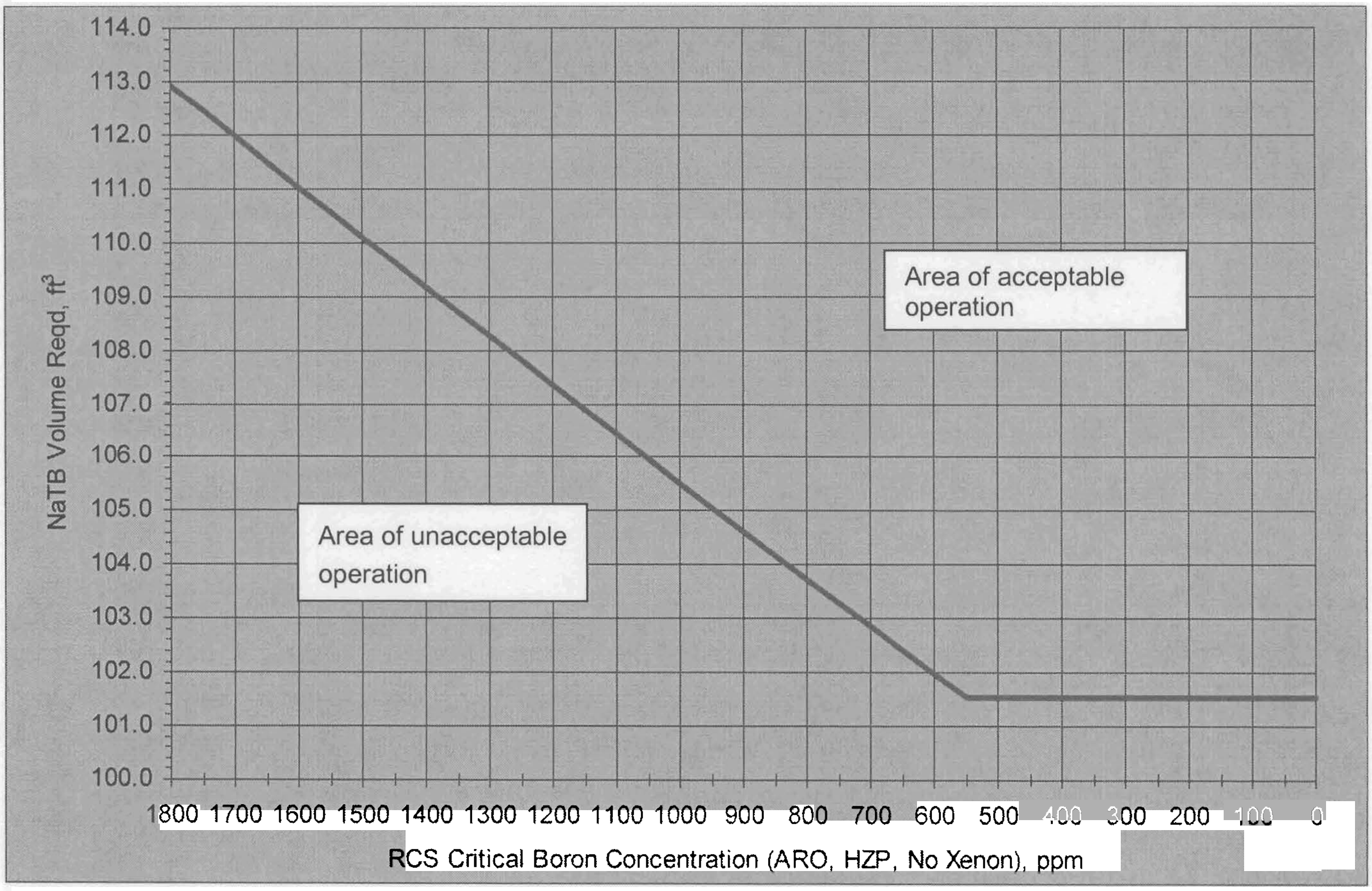
Basis

The normal procedure for starting the reactor is to first heat the reactor coolant to near operating temperature by running the reactor coolant pumps. The reactor is then made critical. The energy stored in the reactor coolant during the approach to criticality is substantially equal to that during power operation and therefore all engineered safety features and auxiliary cooling systems are required to be fully operable.

 Amendment No. ~~17,39,43,47,64,74,77,~~
~~100,103,133,141,157,161,179,201,221,232,~~ ~~247~~

2.0 **LIMITING CONDITIONS FOR OPERATION**
2.3 Emergency Core Cooling System (Continued)

Figure 2-3
NaTB Volume Required for RCS Critical Boron Concentration (ARO, HZP, No Xenon)



 Amendment No. ~~232, 247~~

3.0 **SURVEILLANCE REQUIREMENTS**

3.6 Safety Injection and Containment Cooling Systems Tests

Applicability

Applies to the safety injection system, the containment spray system, the containment cooling system and air filtration system inside the containment.

Objective

To verify that the subject systems will respond promptly and perform their intended functions, if required.

Specifications

(1) Safety Injection System

System tests shall be performed on a refueling frequency. A test safety feature actuation signal will be applied to initiate operation of the system. The safety injection and shutdown cooling system pump motors may be de-energized for this portion of the test.

A second overlapping test will be considered satisfactory if control board indication and visual observations indicate all components have received the safety feature actuation signal in the proper sequence and timing (i.e., the appropriate pump breakers shall have opened and closed, and all valves shall have completed their travel).

(2) Containment Spray System

a. System tests shall be performed on a refueling frequency. The test shall be performed with the isolation valves in the spray supply lines at the containment blocked closed. Operation of the system is initiated by tripping the normal actuation instrumentation.

b. At least every ten years the spray nozzles shall be verified to be open.

c. The test will be considered satisfactory if:

(i) Visual observations indicate that at least 264 nozzles per spray header have operated satisfactorily.

(ii) No more than one nozzle per spray header is missing.

d. Representative samples of Hydrated Sodium Tetraborate (NaTB) that have been exposed to the same environmental conditions as that in the mesh baskets shall be tested on a refueling frequency by:

3.0 SURVEILLANCE REQUIREMENTS

3.6 Safety Injection and Containment Cooling Systems Tests (Continued)

Operation of the system for 10 hours every month will demonstrate operability of the filters and adsorbers system and remove excessive moisture build-up on the adsorbers.

Demonstration of the automatic initiation capability will assure system availability.

Determination of the volume of buffering agent in containment must be performed due to the possibility of leaking valves and components in the containment building that could cause dissolution of the buffering agent during normal operation.

A refueling frequency shall be utilized to visually determine that the volume of buffering agent contained in the buffering agent baskets is within the area of acceptable operation based on the buffering agent volume required by Figure 2-3. A measured value or the Technical Data Book (TDB) II, "Reactivity Curves" may be used to obtain a hot zero power (HZP) critical boron concentration (CBC). The "as found" volume of buffering agent must be within the area of acceptable operation of Figure 2-3 using this HZP CBC value. Prior to exiting the refueling outage, visual buffering agent volume determination is performed to ensure that the "as-left" volume of buffering agent contained in the baskets is ≥ 112.9 ft^3. This requirement ensures that there is an adequate quantity of buffering agent to adjust the pH of the post-LOCA sump solution to a value ≥ 7.0 for HZP CBC up to 1800 ppm.

Testing must be performed to ensure the solubility and buffering ability of the NaTB after exposure to the containment environment. A representative sample of 1.39 to 1.42 grams of NaTB from one of the baskets in containment is submerged in 0.99 – 1.01 liters of water at a boron concentration of 2436 – 2456 ppm (equivalent to a RCS boron concentration of 1800 ppm - Figure 2-3) using boric acid. At a standard temperature of 115 – 125°F, without agitation, the solution must be left to stand for 4 hours. The liquid is then decanted and mixed, the temperature is adjusted to 75 – 79°F and the pH measured. At this point, the pH must be ≥ 7.0. The representative sample weight is based on the minimum required NaTB weight of 5418 pounds, less the quantity required to account for acidic radiolysis products (758 pounds), and maximum possible post-LOCA sump volume of 398,445 gallons, normalized to a 1.0 liter sample. At a manufactured density of 48.0 lb_m/ft^3, 5418 pounds corresponds to the minimum volume of 112.9 ft^3.

For dissolution testing, the boron concentration of the test water is representative of the maximum possible boron concentration corresponding to the maximum possible post-LOCA sump volume. The post-LOCA sump volume originates from the Reactor Coolant System (RCS), the Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. The cumulative boron concentration is based on a maximum RCS HZP CBC with no Xenon at Beginning of Cycle conditions, SIRWT and SIT boron concentrations at maximum allowed values of 2,350 ppm and maximum BAST concentration of 4.5 % wt. Agitation of the test solution is prohibited since an adequate standard for the agitation intensity cannot be specified. The test time of 4 hours is necessary to allow time for the dissolved NaTB to naturally diffuse through the sample solution. In the post-LOCA containment sump, rapid mixing would occur, significantly decreasing the actual amount of time before the required pH is achieved. This would ensure achieving a pH ≥ 7.0 by the onset of recirculation after a LOCA.

LTR-CDME-06-115-NP, Rev. 1, "Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station," Revision 1, November 15, 2006

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Our ref: LTR-CDME-06-115-NP, Revision 1

November 15, 2006

Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station, Revision 1

Introduction

In the event of a loss of coolant accident (LOCA) at the Omaha Public Power District's (OPPD) Fort Calhoun Station (FCS), core cooling would be provided by the Emergency Core Cooling System (ECCS). In operation, ECCS coolant circulation flow is partially provided by the High Pressure Safety Injection (HPSI) pumps, which take suction from the containment sump through a set of sump strainers (Reference 1). The potential for sump strainer blockage due to debris either generated during the LOCA has been identified as a generic safety concern (Reference 2).

Currently, the ECCS coolant at FCS contains boric acid for reactivity control, and following RAS trisodium phosphate (TSP) is dissolved in the post-LOCA containment sump fluid mixture to adjust the pH to greater than 7.0. The adjustment of pH is performed primarily to maintain fission product iodine in solution. Below pH 6.5, iodine may come out of solution as iodine gas, and eventually be released to the environment, resulting in increased off site radiation exposure (Reference 3). As a side benefit, maintaining pH above 7.0 reduces general corrosion of structural materials in containment, particularly aluminum and carbon/low alloy steels. It also reduces the potential for localized attack of austenitic stainless steel system components by aggressive species such as chloride (e.g., chloride induced stress corrosion cracking).

In the event of a LOCA, containment materials that are not normally wetted may either be contacted by containment spray or become fully submerged in the containment sump pool. Testing and industry data (Reference 16) has demonstrated that these materials will release a variety of chemical species due to dissolution or corrosion (References 4 and 5) or destruction from the pipe break. The predominant dissolved species are calcium, aluminum and silicate. These species may combine with each other to produce precipitates (e.g., sodium aluminum silicate) or combine with TSP to produce calcium phosphate. Any such precipitates generated may potentially combine with other types of debris in the system which would increase the severity of sump strainer blockage.

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Due to the large quantity of calcium silicate insulation debris that may be generated during a LOCA at FCS, a correspondingly large quantity of calcium phosphate precipitate could be generated. Therefore, OPPD has undertaken a program to evaluate switching from TSP to an alternative buffering agent.

In addition to minimizing precipitate generation, the following properties must be comparable to those of TSP:

1. Quantity required to adjust pH to >7.0, particularly, the required volume should fit in existing baskets
2. Complete dissolution in hot (150°F) water in less than four hours
3. Affordability and ready availability
4. No demonstrated deleterious effects, e.g., corrosion to key containment structural materials
5. Does not adversely affect the solubility of boric acid, or lead to an increase in boric acid precipitation on structures
6. Resistant to degradation from radiation, elevated temperatures and humidity (storage life)
7. Material does not create habitability concerns during storage or handling

Issues associated with the ECCS buffering agents currently used in Pressurized Water Reactors (PWR) are a generic industry concern. Therefore, the PWR Owners Group sponsored a program to evaluate alternative buffering agents for ECCS applications in all PWRs (Reference 6). The results of this evaluation were reported in Reference 7. The study concluded that sodium tetraborate decahydrate (NaTB or Borax) was a suitable replacement for plants currently using TSP. A discussion of the properties of NaTB relative to TSP is provided in the succeeding sections of this report.

Comparison of NaTB to TSP

Quantity Required to Adjust pH above 7.0

The quantity of buffering agent required to adjust pH to greater than 7.0 is determined at the maximum reactor coolant system boron concentration at the beginning of the operating cycle and at the maximum sump volume. Additional buffering agent must also be included to neutralize acids that may be generated from radiolysis of water and air (nitric acid, HNO_3) and radiolysis of electric cable jacket material (hydrochloric acid, HCl). On a mass basis, the quantity of NaTB required to neutralize radiolytically generated acids is comparable to the quantity of TSP required since the molecular weights are nearly identical (380 grams per mole for TSP and 381 grams per mole for NaTB). For pH values less than 7.8, the quantity of NaTB required to adjust the pH of a boric acid solution is less than the quantity of TSP required. Above this value, relatively more NaTB is required to achieve an equivalent pH.

From Reference 8, the maximum RCS boron concentration is 1800 ppm. The maximum quantity of fluid in the sump pool is 398,445 gallons. (Reference 9) This includes the inventory of the Reactor Coolant System (RCS) , Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. Under these conditions, a total of 3543 pounds (1611 kg) of NaTB is required to adjust the pH of the water in the sump pool to 7.0 or greater. An additional 758 pounds (344.3 kg) is required to neutralize radiolytically produced acids. Thus, a total of 4301 pounds (1955 kg) of NaTB should be loaded in the buffering agent baskets (Reference 9). At a bulk (manufactured) minimum density of 59.3 pounds/ft^3 (Reference 10), 4301 pounds of NaTB corresponds to 72.5 ft^3. Currently, 128.3 ft^3 of TSP is stored in the FCS buffering agent baskets. At a bulk density of 53 pounds/ft^3, this equates to 6800 pounds. Thus, the required quantity of NaTB will easily fit in the buffering agent baskets currently installed in the FCS containment.

In the current hydrogen generation evaluation at FCS, the maximum evaluated ECCS pH is 7.5 (Reference 8). At the minimum possible sump boron concentration of 1681 ppm and minimum sump volume of 328,612 gallons, addition of 4755pounds of NaTB will result in a pH of 7.5 (Reference 9). This corresponds to a volume of 80.3 ft^3 at a bulk minimum density of 59.3 pounds/ft^3.

Dissolution Rate

As reported in Reference 7, the dissolution rates for NaTB and TSP were determined at a concentration of 10 grams per liter at 150°F. Testing was performed with both fresh product and product stored under simulated containment conditions for 30 days. For the fresh products, the dissolution rates were essentially the same for NaTB (2 minutes, 20 seconds) and TSP (2 minutes, 21 seconds). For the aged product, TSP dissolved somewhat faster than NaTB (2 minutes, 37 seconds versus 3 minutes, 29 seconds), but both readily dissolved.

Corrosion Inhibition

Both TSP and NaTB are used as corrosion inhibitors for carbon/low alloy steels (Reference 11). Thus, the steady state corrosion rates for these materials would be expected to be low for either buffer. As reported in Reference 7, corrosion of A508 Class 2 carbon steel was determined after exposure to buffered solutions at 150°F for 14 days. The measured corrosion in NaTB and TSP were essentially identical (1.03 g/m^2 for NaTB and 1.00 g/m^2 for TSP). Based on its higher corrosion resistance, corrosion to stainless steel would be one or more orders of magnitude lower, and neither NaTB nor other borates have been shown to cause localized corrosion attack in high chromium alloys such as stainless steel.

Corrosion of submerged aluminum is exceptionally low in TSP due to formation of an aluminum phosphate conversion coating. Corrosion of submerged aluminum in NaTB is higher since a comparable aluminum borate coating does not readily form. As reported in Reference 7, the measured values after 14 days exposure were 17.8 g/m^2 for NaTB and 0.55 g/m^2 for TSP. The overall effect of increased corrosion of submerged aluminum in the presence of NaTB relative to TSP is not significant since dissolved silicate will also inhibit corrosion of submerged aluminum. It should be noted that the inhibitory effects of phosphate and silicate are not included in the PWROG chemical model (Reference 12) since these effects have not been quantified for all chemistry conditions.

Boric Acid Solubility

As reported in Reference 7, both NaTB and TSP increase the solubility of boric acid. At an equivalent pH (7.0) and boron concentration (2500 ppm), the degree of increase in the presence of TSP is higher than in the presence of NaTB (16.4 percent for TSP versus 7.7 percent for NaTB). Thus, while NaTB does provide some additional margin against boric acid precipitation, the margin is lower than with TSP. Consequently, because NaTB is less effective than TSP at increasing the boric acid solubility limit, the hot leg switchover (HLSO) time must be recalculated for Fort Calhoun.

Environmental Stability

As reported in Reference 7, in the initial test of environmental stability, buffer samples were exposed to a simulated containment environment of 100 percent humidity at 150°F. However, after 14 days under these conditions TSP liquefied completely, and thus the conditions were considered to be too severe. In the initial exposure, NaTB remained solid but did clump. The test was repeated at 30 percent humidity and 150°F. After 30 days under these conditions, clumping was observed in both TSP and NaTB, but both buffers readily dissolved in hot (150°F) water. The volume change due to settling/densification after exposure to these conditions was not quantified, but visually appeared to be similar for NaTB and TSP. On the basis of these results, the stability of NaTB in containment environment should be considered comparable to slightly better than TSP. NaTB has been used for many years in Ice Condenser plants and its stability to exposure to gamma radiation has been demonstrated to be good. In these plants, the NaTB is dissolved in ice that is stored in baskets in containment. Thus, the radiation fields to which the NaTB is subject in Ice Condenser plants is comparable to the fields to which the NaTB would be exposed at FCS. Additionally, a similar chemical (sodium pentaborate) is routinely stored in containments for emergency use in Boiling Water Reactor plants (Reference 13) and also shows no degradation due to radiation exposure over time.

Precipitate Formation

As reported in Reference 7, testing was performed to determine whether the buffering agents would react with aluminum or calcium to form precipitates. The testing was performed with both NaTB and TSP. The testing also investigated the condition under which precipitates would form, and the relative quantities. The test results showed that no precipitates formed in NaTB with addition of either metal at pH values of 8.0 or less. Precipitates formed in TSP with both metals irrespective of pH (only pH values greater than 7.0 were evaluated). At 150°F and pH 8.5, an aluminum borate precipitate formed with NaTB at aluminum concentrations in excess of 177 ppm, and a calcium borate precipitate formed at calcium concentration in excess of 254 ppm. The borate precipitates dissolved when pH was reduced to less than 8.0. Note that the borate precipitates did not form at ambient temperature at these aluminum or calcium concentrations. Since the nominal sump pH at FCS will be less than 8.0, there is no concern with borate precipitation. Additionally, the maximum predicted dissolved aluminum concentration at FCS is 22 ppm, and the maximum calcium concentration is 126 ppm. Both values are less than the applicable threshold values for precipitate formation at elevated pH. Finally, any precipitates formed under transient high pH/high local metal concentration conditions will re-dissolve in the presence of lower steady state pH conditions and thus would not contribute to sump screen blockage.

Under nominal conditions at FCS (pH 7.5, minimum sump volume), the PWROG model predicts formation of 227 kg of sodium aluminum silicate $NaAlSi_3O_8$ if either NaTB or TSP is used for buffering. With TSP, an additional 513 kg of calcium phosphate precipitate is generated. Thus, use of NaTB rather than TSP results in a net decrease of 69 percent in the quantity of precipitate generated (227 kg with NaTB versus 740 kg with TSP). Table 1 provides a summary of the predicted precipitate generation.

	NaTB pH 7.5		TSP pH 7.5	
	Max recirculation volume		Max recirculation volume	
	(kg)	(ppm)	(kg)	(ppm)
$NaAlSi_3O_8$	227.0	152.2	227.0	152.2
AlOOH	0.00	0.00	0.00	0.00
$Ca_3(PO_4)_2$	0.00	0.00	513.10	344.0

Table 1: Predicted Quantities of Precipitates in a Post-LOCA Environment for FCS (Reference 14)

Increased Boron for Reactivity Control

A serendipitous benefit to use of NaTB as an ECCS buffering agent is an increase in net boron for reactivity control. For a maximum sump volume of 398,445 gallons, addition of 1955 kilograms of NaTB will provide an additional 150 ppm boron for reactivity control. This represents an increase of about 8.95 percent for the minimum boron condition (1681 ppm boron). As noted above, the presence of additional boron as sodium tetraborate increases the solubility of boric acid.

Buffering Capacity

To determine the relative buffering capacity of NaTB and TSP, stock solutions of 1500 ppm boric acid were prepared and the pH was adjusted to 7.5 with either NaTB or TSP. In one test, solid boric acid (a weak acid) was added in 300 ppm increments and the resulting pH was measured. In a second test, a 1 molar (1M) hydrochloric acid solution (a strong acid) was added in 73 ppm increments. The results of this testing showed that NaTB and TSP have comparable buffering capacity (see Figures 1 and 2).

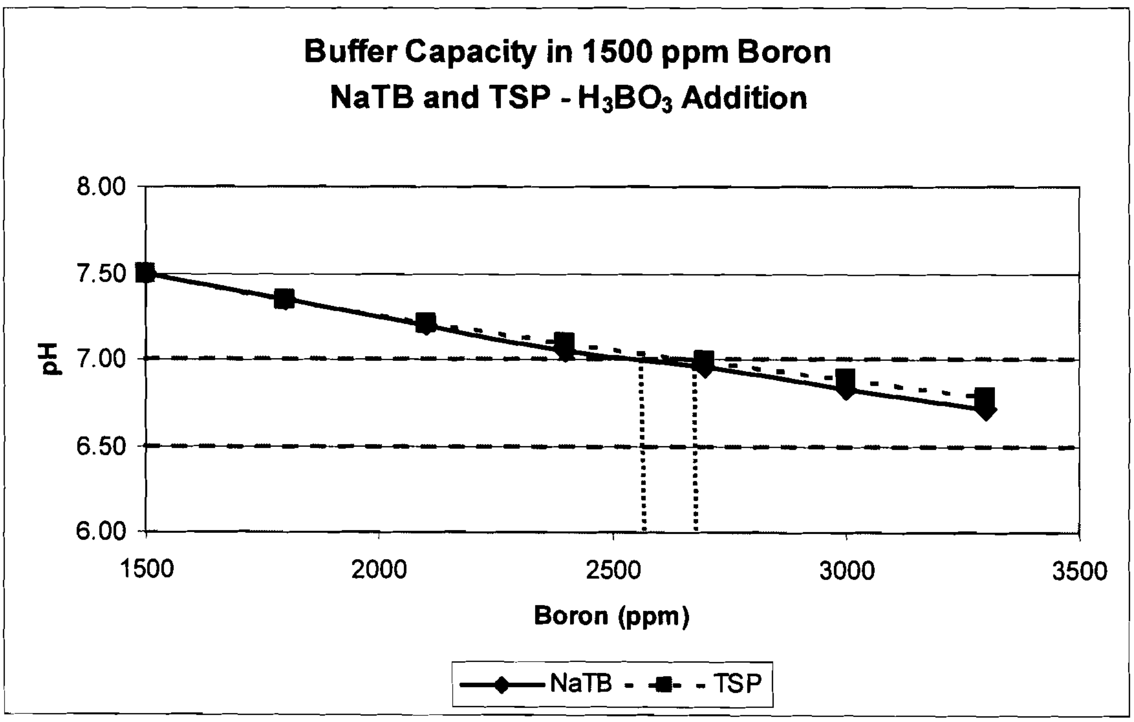

Figure 1: Buffering Capacity of NaTB and TSP for Boric Acid Addition

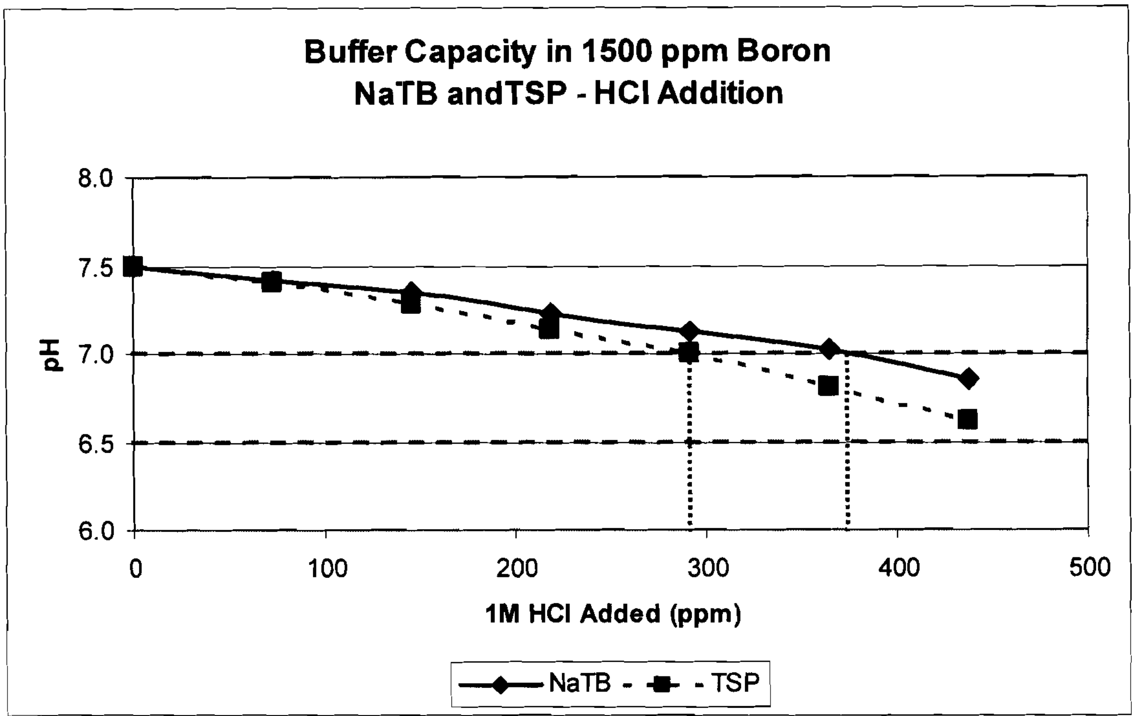

Figure 2: Buffering Capacity of NaTB and TSP for Hydrochloric Acid Addition

Summary

In summary, sodium tetraborate decahydrate (NaTB) is an acceptable alternative to trisodium phosphate dodecahydrate (TSP) for use as the ECCS buffering agent at FCS. Use of NaTB will result in a net reduction in precipitate formation of 69 percent, with no adverse side effects. Additionally, use of NaTB will provide additional dissolved boron for reactivity control.

- NaTB provides a comparable buffering capacity to TSP with a comparable quantity of buffering agent, so that no modification to the existing buffer delivery scheme would be required;
- no new types of precipitates are formed in the target pH of 7.0 to 8.0, irrespective of the calcium loading;
- corrosion of structural materials is comparable to that expected with TSP;
- as with TSP, NaTB addition increases the solubility of boric acid, and thereby provides contingency against boric acid precipitation under post-accident conditions;
- NaTB has been evaluated for other potential chemical effects as part of the PWROG Program (Reference 12) and the ICET program (References 4 and 5); and
- NaTB is already in use at ice condenser plants and has a long and acceptable track record.

Application Considerations

Buffer Surveillance

In accordance with Technical Specification 3.6.d, the buffering capability of the TSP stored in the containment buffering agent baskets must be periodically confirmed by performing bench scale testing of samples taken from the baskets. The revised text for performance of this testing for NaTB is provided below.

> "Testing must be performed to ensure the solubility and buffering ability of the NaTB after exposure to the containment environment. A representative sample of 1.24 to 1.27 grams of NaTB from one of the baskets in containment is submerged in 0.99 – 1.01 liters of water at a boron concentration of 2436 – 2456 ppm using boric acid. At a standard temperature of 115 – 125°F, without agitation, the solution shall be left to stand for 4 hours. The liquid is then decanted and mixed, the temperature is adjusted to 75 – 79°F and the pH measured. At this point, the pH must be ≥ 7.0. The representative sample weight is based on the minimum required NaTB weight of 4301 pounds, less the quantity required to account for acidic radiolysis products (758 pounds), and maximum possible post-LOCA sump volume of 398,445 gallons, normalized to a 1.0 liter sample. At a manufactured minimum density of 59.3 lb_m/ft^3, 4301 pounds corresponds to the minimum volume of 72.5 ft^3. The boron concentration of the test water is representative of the maximum possible boron concentration corresponding to the maximum possible post-LOCA sump volume. The post-LOCA sump volume originates from the Reactor Coolant System (RCS), the Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. Agitation of the test solution is prohibited since an adequate standard for the agitation intensity cannot be specified. The test time of 4 hours is necessary to allow time for the dissolved NaTB to naturally diffuse through the sample solution. In the post-LOCA containment sump, rapid mixing would occur, significantly decreasing the actual amount of time before the required pH is achieved. This would ensure achieving a pH ≥ 7.0 by the onset of recirculation after a LOCA."

Buffer Specifications

The preferred physical form for NaTB for ECCS application is granular crystals with a minimum sodium tetraborate decahydrate concentration of 98 percent. This product has a nominal bulk density of 62 pounds/ft^3, and is available from a variety of vendors (e.g., US Borax). Technical grade product will typically meet required specifications. For consistency with normal operating chemistry limits on impurities (Reference 15), chloride, fluoride and sulfate should be less than 100 ppm, and heavy metals (as lead) should be less than 5 ppm.

The decahydrate is the highest hydrated form of sodium tetraborate salt. Therefore, NaTB will not pick up additional waters of hydration during storage in areas with elevated humidity. In fact, if exposed to dry, warm air for extended periods NaTB may lose minor amounts of its waters of hydration. This behavior is termed efflorescence, and is typically noted on material safety data sheets/product data sheets for NaTB. However, in the conditions present in the FCS containment, NaTB, effloresce is not expected. Sodium tetraborate is also available in anhydrous form and as a pentahydrate. Although use of sodium tetraborate in these forms would likely be acceptable, testing would be required to determine the quantity required to adjust pH and environmental stability and addition of waters of hydration would need to be considered.

References

1. FCS System Training Manual, Revision 34, Vol. 15 Emergency Core Cooling System.
2. Generic Safety Issue 191 (GSI-191), "Assessment of Debris Accumulation on Pressurized Water Reactor (PWR) Sump Performance," September 1996.
3. Beahm, E. C., et al., NUREG 5950, "Iodine Evolution and pH Control," December 1992.
4. LA-UR-05-6996, "Integrated Chemical Effects Test Project: Test #3 Data Report," October 2005.
5. Oras, J., et al., "Chemical Effects/Head Loss Testing Quick Look Report, Tests ICET 3-4 to 11," January 20, 2006.
6. PWROG PA-SEE-0285, "Alternate Buffer for ECCS," February 2006.
7. WCAP-16596-NP, Rev. 0, "Evaluation of Alternative Emergency Core Cooling System Buffering Agents," July 2006.
8. Fort Calhoun Station letter NPD-DEN-06-0072, Revision 2, "Design Inputs for Calculations Related to Replacement of Trisodium Phosphate," August 16, 2006.
9. Westinghouse Calculation Note CN-CSA-06-10, Revision 1, "OPPD Alternate Buffer Calculation," November 2006.
10. Fort Calhoun Station DIT Number DIT EC38570-02, "Guaranteed Density of Sodium Tetraborate (NaTB)," August 10, 2006.
11. Revie, R. Winston, ed. *Uhlig's Corrosion Handbook* (2nd Edition). John Wiley & Sons, 2000.
12. WCAP-16530-NP, Rev. 0, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," February 2006.
13. Eagle Picher Technical Bulletin EP-SSGC-NAPB, Rev. 3, "Enriched Sodium Pentaborate," July 2002.
14. Westinghouse Calculation Note CN-CSA-06-11, "OPPD GSI-191 Chemical Effects Evaluation," August 2006.
15. EPRI Report 11002884, Rev. 5, *Pressurized Water Reactor Primary Water Chemistry Guidelines*, EPRI, Palo Alto, CA, 2003.
16. NRC Generic Letter 2004-02 "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" dated September 13, 2004

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Addendum to LTR-CDME-06-115-NP, Rev. 1, "Additional Testing of Sodium Tetraborate Buffer"

September 6, 2007

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CFTC-07-37
September 6, 2007

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OMAHA PUBLIC POWER DISTRICT
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Additional Testing of Sodium Tetraborate Buffer
Transmittal of Addendum to LTR-CDME-06-115-NP

References:

1. LTR-CDME-07-137-NP Revision 2, Addendum to LTR-CDME-06-115-NP, Rev. 1 to achieve a Minimum Sump pH of 7.05
2. OPPD Contract 00083453 Release 18

Dear Dr. Gasper:

Please find attached Reference 1 for your use. This is being provided in accordance with Reference 2.

If there are any questions, please contact me at 423-752-2835 or John Maruschak at 412-374-3512.

Very truly yours,

Krish M. Rajan
Customer Projects Manager

cc: Carmen Ovici
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Your ref: LTR-CDME-06-115-NP, Rev.1, "Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station, Revision 1", November 15, 2006.

LTR-CDME-07-101, "Comparison Evaluation of OPPD Sodium Tetraborate to a Control Sample of Sodium Tetraborate", July 3, 2007.

Our ref: LTR-CDME-07-137-NP, Revision 2

September 6, 2007

Subject: **Addendum to LTR-CDME-06-115-NP, Rev. 1 to achieve a Minimum Sump pH of 7.05**

During 2006 Fort Calhoun had switched sump buffers from trisodium phosphate (TSP) to sodium tetraborate decahydrate (NaTB). In support of the sump buffer change from TSP to NaTB, a summary report was developed. (Reference 1) The sump buffer is dissolved in the post-LOCA containment sump fluid mixture to adjust the pH to greater than 7.0. The adjustment of pH is performed primarily to maintain fission product iodine in solution. Below pH 6.5, iodine may come out of solution as iodine gas, and eventually be released to the environment, resulting in increased off site radiation exposure (Reference 2). As a side benefit, maintaining pH above 7.0 reduces general corrosion of structural materials in containment, particularly aluminum and carbon/low alloy steels. It also reduces the potential for localized attack of austenitic stainless steel system components by aggressive species such as chloride (e.g., chloride induced stress corrosion cracking). A major benefit of the sump buffer change from TSP to NaTB was the mitigation of calcium phosphate precipitate formation in the event of a LOCA. This letter has been developed as an addendum to LTR-CDME-06-115-NP (Reference 1), to provide a summary and guidance for Fort Calhoun to achieve a minimum sump pH of 7.05.

In accordance with Technical Specification 3.6.d, the buffering capability of the NaTB stored in the containment buffering agent baskets must be periodically confirmed by performing bench scale testing of samples taken from the baskets. Based on the sample size determined in Reference 1, Fort Calhoun was able to achieve a pH of 7.0 satisfying the requirements of the surveillance test criteria. Although the surveillance test had satisfied the pH 7.0 criteria, Fort Calhoun had requested sufficient quantity of NaTB to achieve a minimum sump pH of 7.05 applying a margin of conservatism to the analysis. As a result of NaTB comparison testing (Reference 3), a polynomial relationship between boron concentration (ppm) and NaTB concentration (g/L) was developed for a pH of 7.05 based on US Borax NaTB.

The following sections are modifications to Reference 1 data to represent a minimum sump pH of 7.05.

Quantity Required to Adjust to Minimum pH of 7.05

The quantity of buffering agent required to adjust the minimum sump pH to 7.05 is determined at the maximum reactor coolant system boron concentration at the beginning of the operating cycle and at the maximum sump volume. Additional buffering agent must also be included to neutralize acids that may be generated from radiolysis of water and air (nitric acid, HNO_3) and radiolysis of electric cable jacket material (hydrochloric acid, HCl).

From Reference 4, the maximum RCS boron concentration is 1800 ppm. The maximum quantity of fluid in the sump pool is 398,445 gallons. (Reference 5) This includes the inventory of the Reactor Coolant System (RCS), Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. Under these conditions, a total of 4660 pounds (2113.7 kg) of NaTB is required to adjust the pH of the water in the sump pool to 7.05 or greater. An additional 758 pounds (343.8 kg) is required to neutralize radiolytically produced acids. Thus, a total of 5418 pounds (2457.6 kg) of NaTB should be loaded in the buffering agent baskets. At a bulk (manufactured) minimum density of 48.0 pounds/ft^3 (Reference 6), 5418 pounds of NaTB corresponds to 112.9 ft^3. Formerly, 128.3 ft^3 of TSP is stored in the FCS buffering agent baskets. At a bulk density of 53 pounds/ft^3, this equates to 6800 pounds. Thus, the required quantity of NaTB to achieve a minimum pH of 7.05 will easily fit in the buffering agent baskets currently installed in the FCS containment.

Reference 1 contains information regarding the FCS hydrogen generation evaluation at a pH of 7.5. However, the requirement to calculate the amount of hydrogen generated post-accident has since been removed from the design basis (Reference 7). The EEQ program had evaluated the qualification of electrical components in containment up to a pH of 8.0 (Reference 8). At the minimum possible sump boron concentration of 1681 ppm and minimum sump volume of 328,612 gallons, addition of 15,200 pounds of NaTB will result in a pH of 8.0. This corresponds to a volume of 316.7 ft^3 at a bulk minimum density of 48 pounds/ft^3. In the case of all five baskets filled with NaTB (131.9 ft^3) at a maximum bulk density of 64 lbs/ft^3 the NaTB mass would be 8448 lbs, 6752 lbs less than the mass required to exceed a pH of 8.0. Based on the significant amount of additional buffer required to achieve a pH of 8.0 relative to the 7.05 analysis amount and the maximum volume capacity of the baskets OPPD should never exceed a pH of 8.0 using NaTB.

Buffer Surveillance (additional guidance is provided in Reference 3)

In accordance with Technical Specification 3.6.d, the buffering capability of the TSP stored in the containment buffering agent baskets must be periodically confirmed by performing bench scale testing of samples taken from the baskets. The revised text for performance of this testing for NaTB is provided below.

> "Testing must be performed to ensure the solubility and buffering ability of the NaTB after exposure to the containment environment. A representative sample of 1.39 to 1.42 grams of NaTB from one of the baskets in containment is submerged in 0.99 – 1.01 liters of water at a boron concentration of 2436 – 2456 ppm using boric acid. At a standard temperature of 115 – 125°F, without agitation, the solution shall be left to stand for 4 hours. The liquid is then decanted and mixed, the temperature is adjusted to 75 – 79°F and the pH measured. At this point, the pH must be $\geq$ 7.0. The representative sample weight is based on the minimum required NaTB weight of 5418

pounds, less the quantity required to account for acidic radiolysis products (758 pounds), and maximum possible post-LOCA sump volume of 398,445 gallons, normalized to a 1.0 liter sample. At a manufactured minimum density of 48 lb_m/ft^3, 5418 pounds corresponds to the minimum volume of 112.9 ft^3. The boron concentration of the test water is representative of the maximum possible boron concentration corresponding to the maximum possible post-LOCA sump volume. The post-LOCA sump volume originates from the Reactor Coolant System (RCS), the Safety Injection Refueling Water Tank (SIRWT), the Safety Injection Tanks (SITs) and the Boric Acid Storage Tanks (BASTs). The maximum post-LOCA sump boron concentration is based on a cumulative boron concentration in the RCS, SIRWT, SITs and BASTs of 2446 ppm. Agitation of the test solution is prohibited since an adequate standard for the agitation intensity cannot be specified. The test time of 4 hours is necessary to allow time for the dissolved NaTB to naturally diffuse through the sample solution. In the post-LOCA containment sump, rapid mixing would occur, significantly decreasing the actual amount of time before the required pH is achieved. This would ensure achieving a pH $\geq$ 7.0 by the onset of recirculation after a LOCA."

The following test method may be used for supplier quality control (from Reference 3)

A representative batch sample of 1.39 to 1.42 grams of Sodium Tetraborate Decahydrate should be dissolved in 0.99 – 1.01 liters of water at a boron concentration of 2436 – 2456 ppm using boric acid. The solution should be thoroughly mixed for five minutes. Following the five minutes of mixing, the pH measured. At this point, the pH must be $\geq$ 7.00.

References:

1. LTR-CDME-06-115-NP, Rev.1, "Summary Report for Testing of Alternative Emergency Core Coolant System Buffering Agents for Fort Calhoun Station, Revision 1", November 15, 2006.
2. Beahm, E. C., et al., NUREG 5950, "Iodine Evolution and pH Control," December 1992.
3. LTR-CDME-07-101, "Comparison Evaluation of OPPD Sodium Tetraborate to a Control Sample of Sodium Tetraborate", July 3, 2007.
4. Fort Calhoun Station letter NPD-DEN-06-0072, Revision 2, "Design Inputs for Calculations Related to Replacement of Trisodium Phosphate," August 16, 2006.
5. Westinghouse Calculation Note CN-CSA-06-10, Revision 1, "OPPD Alternate Buffer Calculation," November 2006.
6. Email from Tom Wilhelm (Rio Tinto Minerals) to Carmen Ovici, "RE: Rio Tinto Minerals – Borax SQ for Omaha Power", July 9, 2007. (Attached)
7. Updated Safety Analysis Report Fort Calhoun Station, USAR-14.17, Section 14.17, "Safety Analysis Generation of Hydrogen in Containment", Change No. EC 39642, November 22, 2006.
8. EEQ EA-FC-95-031, "Evaluation of SIRWT Boron Concentration Increase from 1900 PPM (>= 2000 PPM <= 2400 PPM) on EEQ Components", Rev 2., January 10, 2005.

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Attachment:
From: Wilhelm, Tom (RTM) [mailto:Tom.Wilhelm@riotinto.com]
Sent: Monday, July 09, 2007 2:56 PM
To: OVICI, CARMEN; Blondeel, Melyne (RTMFR)
Cc: WASZAK, CAROL L; MARCELLUS, MATTHEW R; Roggenbuck, David B. (RTM)
Subject: RE: Rio Tinto Minerals - Borax SQ for Omaha Power

Sorry for the delay but I was traveling this morning.

To answer your question, the lowest it would be is similar to our Borax Technical Granular material. As indicated in our Service Bulletin and I have copied here would be lowest value. As we re-crystallize our technical grade to make our Borax SQ material in Coudekerque, France, the bulk density will increase somewhat as you have noted in the lot numbers that have been targeted.

I have checked with some of our other PhD chemists and they confirm this change in physical chemistry. The crystals become slight larger and thus the bulk density number increases. Thus the numbers would not be lower than 48 lbs per cubic foot. Thus it is the lowest they should go.

Product	Bulk Density lb./ft^3 (kg/m^3)	Angle of Repose	Degree of Abrasiveness	Corrosivity
Borax Decahydrate	48 (769)	35°	Non-abrasive	None. Solution slightly alkaline

Regarding the "X" axis question I am going to follow-up on Tuesday with Melyne our Quality Director and would ask her to explain the values indicated. I believe they refer to Millimeters. I will check also with our Boron Lab for an answer as well as time is critical to our becoming approved.

Tom

CC:

Carmen Ovici / OPPD
Carol Waszak / OPPD
Chris Burton / Westinghouse
John Maruschak / Westinghouse
Richard Reid / Westinghosue