Entergy Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213
Tel 601-368-5138

Ron Gaston
Director, Nuclear Licensing

10 CFR 50.90

1CAN072001

July 21, 2020

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

Subject: Supplemental Information Related to License Amendment Request to Replacement of Reactor Building Spray Sodium Hydroxide Additive with a Passive Reactor Building Sump Buffering Agent Sodium Tetraborate

Arkansas Nuclear One, Unit 1
NRC Docket No. 50-313
Renewed Facility Operating License No. DPR-51

By letter dated February 24, 2020 (Reference 1), Entergy Operations, Inc. (Entergy), requested NRC approval of a proposed change to the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TSs) that would replace the current sodium hydroxide Reactor Building (RB) sump buffering agent with sodium tetraborate decahydrate. During the course of review, an error was noted in an equation used in a supporting calculation.

The overall calculational method itself remains valid; however, correction of the equation results in an ~0.4 pH change (more acidic) to several values contained in enclosure of the Reference 1 correspondence. This offset does not invalidate the key results, which remain well within acceptable values:

- RB sump pH remains well over 7 (~7.7 vs ~8.1)
- RB sump pH continues to reach a value of > 7 within 10 minutes of the onset of an accident
- RB sump pH remains below 10.5 over the long term

Notwithstanding the above, Entergy is supplementing the Reference 1 correspondence by including revised values that were affected by the corrected equation. For ease of review, all of the Reference 1 enclosure, absent the associated attachments (i.e., the attachments are not impacted) is being provided. Revision bars are included next to each line that has been modified. Changes are made to the resulting pH and boron concentration values in Section 3.0 (prior to Section 3.1) and Section 3.6 of the enclosure, and a sentence in Section 3.0 is clarified.

This revision does not impact the no significant hazards consideration provided in the original amendment request (Reference 1).

In addition to the required quality assurance reviews performed by both the vendor and Entergy personnel, the revised calculation supporting the values presented in this supplemental letter underwent a complete design re-verification by an independent qualified engineer, largely due to the complexity of the calculation. This independent design verification was performed on the entire calculation. Further, all other supporting calculations for this submittal were re-checked, again by an independent qualified engineer.

No new regulatory commitments are included in this submittal.

In accordance with 10 CFR 50.91, Entergy is notifying the State of Arkansas of Entergy's supplemental information by transmitting a copy of this letter and enclosure to the designated State Official.

If there are any questions or if additional information is needed, please contact Riley Keele, Manager, Regulatory Assurance, Arkansas Nuclear One, at 479-858-7826.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on July 21, 2020.

Respectfully,

ORIGINAL SIGNED BY RON GASTON

Ron Gaston

RWG/dbb

Enclosure: Evaluation of the Proposed Change

References: 1. Entergy Operations, Inc. (Entergy) letter to U. S. Nuclear Regulatory Commission (NRC), *License Amendment Request to Replacement of Reactor Building Spray Sodium Hydroxide Additive with a Passive Reactor Building Sump Buffering Agent Sodium Tetraborate*, Arkansas Nuclear One, Unit 1 (1CAN022001) (ML20056D591), dated February 24, 2020.

cc: NRC Region IV Regional Administrator

NRC Senior Resident Inspector – Arkansas Nuclear One

NRC Project Manager – Arkansas Nuclear One

Designated Arkansas State Official

Enclosure

1CAN072001

Evaluation of the Proposed Change

EVALUATION OF THE PROPOSED CHANGE

1.0 SUMMARY DESCRIPTION

The proposed amendment would modify the Arkansas Nuclear One, Unit 1 (ANO-1) Renewed Operating License DPR-51Technical Specification (TS) 3.6.6, "Spray Additive System." Specifically, the proposed amendment replaces the current Reactor Building (RB) Spray sodium hydroxide (NaOH) additive with a passive RB sump buffering agent, sodium tetraborate, $Na_2B_4O_7$ (NaTB), decahydrate. The requested change does not involve a significant hazards consideration.

2.0 DETAILED DESCRIPTION

2.1 System Design and Operation

The ANO-1 NaOH RB Spray additive system acts to reduce the iodine fission product inventory in the RB atmosphere resulting from a Design Basis Accident (DBA). The RB Spray system supports the Spray Additive System iodine removal function by providing a distribution mechanism for the solution.

The RB Spray and Spray Additive systems perform no function during normal operations. In the event of a loss of coolant accident (LOCA), the Spray Additive system will be automatically actuated upon a RB high-high pressure signal by the Engineered Safeguards Actuation System (ESAS). Actuation of the Spray Additive system opens the NaOH isolation valves, which are powered from independent buses. When the valves are open, the sodium hydroxide solution is ready to be introduced into the RB Spray system headers.

Radioiodine in its various forms is the fission product of primary concern in the evaluation of the dose consequences of an accident. It is absorbed by a sprayed solution from the RB atmosphere. The spray solution is adjusted to an alkaline pH that promotes iodine hydrolysis, in which iodine is converted to nonvolatile forms. Because of its stability when exposed to radiation and elevated temperature, NaOH is the spray additive currently utilized. The Spray Additive system satisfies Criterion 3 of 10 CFR 50.36.

2.2 Current TS Requirements

TS 3.6.6, "Spray Additive System," currently requires the associated NaOH tank and both NaOH flow paths to the respective RB Spray train to be operable in Modes 1 and 2 (reference TS markup pages included in Attachment 1 of this enclosure).

2.3 Reason for the Proposed Change

Entergy Operations, Inc. (Entergy) is currently developing modifications to replace the RB Spray NaOH additive with a passive RB sump buffering agent containing NaTB decahydrate. The new NaTB decahydrate additive will continue to support control of post-accident RB sump pH and maintain effective iodine removal from the RB atmosphere, which is currently provided by the NaOH additive. This change will involve modifying the current ANO-1 TS 3.6.6, "Spray Additive System," with requirements governing the new RB Sump Buffering Agent.

2.4 Description of the Proposed Change

The current TS 3.6.6 requirements governing the operability of the NaOH additive system will be replaced with requirements governing a new RB sump buffering agent, NaTB decahydrate. Consistent with the current specification, the new RB sump buffering agent will be required to be operable in Modes 1 and 2 and, if inoperable, will be required to be restored to an operable status within 72 hours, followed by plant shutdown to Mode 3 if not restored with the allotted 72-hour period.

The operability requirements are established in the revision to TS 3.6.6 by establishing two Surveillance Requirements (SRs):

1. Verifying that the buffering agent baskets contain ≥ 308 ft^3 of NaTB decahydrate at a frequency established by the Surveillance Frequency Control Program (SFCP), and
2. Verifying that a sample from the buffering agent baskets provides adequate pH adjustment of borated water at a frequency established by the SFCP.

The elimination of the current NaOH additive system also requires a change to ANO-1 TS 3.3.6, "Engineered Safeguards Actuation system (ESAS) Manual Initiation," to remove references to the NaOH Spray Additive system. Because the new NaTB decahydrate buffering agent is a passive system and requires no actuation signal, reference to this system within TS 3.3.6 is not necessary.

Refer to Attachments 1, 2, and 3 of this enclosure for a complete illustration of the proposed changes.

3.0 TECHNICAL EVALUATION

To accommodate the use of NaTB decahydrate, three (3) baskets will be seismically secured to the lowest floor of the RB equivalent to that previously approved and installed in ANO-2 (Reference 1). Note that ANO-2 originally adopted use of trisodium phosphate (TSP) as its passive RB sump pH control (Reference 1) and later received approval for use of NaTB decahydrate (Reference 2). Because the use of NaTB decahydrate did not require structural changes previously installed in support of TSP use, Reference 1 contains discussion of the ANO-2 basket structural aspects while Reference 2 discusses the acceptability of replacing TSP with NaTB decahydrate.

Each NaTB decahydrate basket is designed to contain approximately 162 ft^3 of NaTB decahydrate when filled to the maximum volume of the basket. All baskets will be submerged by the minimum post-LOCA flood inventory. As this water collects on the RB floor, the borated water from the Reactor Coolant System (RCS), Core Flood Tanks (CFT), and Borated Water Storage Tank (BWST) will dissolve the NaTB decahydrate. Mixing is achieved as the solution is continuously recirculated by the Emergency Core Coolant System (ECCS) following the recirculation actuation signal.

Initial loading of the NaTB decahydrate baskets is determined based on weight. When the baskets are filled, the level of each basket is documented for reference in evaluating volume. Subsequent periodic surveillances will verify the NaTB decahydrate volume in each basket. This is acceptable since the pH calculation is based on both maximum and minimum manufacturer’s densities for NaTB decahydrate.

Calculations were performed to determine the amount of NaTB decahydrate required to adjust the pH of the RB sump solution to a value of > 7.0. Three cases were considered. The calculations were performed using spreadsheets in accordance with engineering controls, thus computer codes/programs were not used to determine the pH values. The calculations verified pH would remain above 7 over the 30-day post-accident period conservatively assuming strong acid generation occurring in the first 48 hours of the accident.

The first case evaluated was the TS Limit Minimum Case, corresponding to the minimum amount of NaTB to be required by the TSs. This case considers a fill height of 2.85 ft, corresponding to 308 ft^3 of NaTB decahydrate in the three baskets. Considering a bulk (manufactured) minimum density of 48.7 lbs/ft^3, this corresponds to 15,000 lbs of NaTB decahydrate. The pH exceeds 7.0 within approximately 10 minutes of the start of the accident. This results in a long-term sump pH of approximately 7.69, with complete dissolution of the NaTB occurring prior to start of recirculation when the pH will be approximately 7.77.

The second case considered the baskets are filled to a minimum height of 4.1 ft and consisting of a bulk (manufactured) minimum density of 48.7 lbs/ft^3. This case is expected to be the administrative surveillance limit. This corresponds to the baskets holding 443 ft^3 or 21,561 lbs of NaTB decahydrate. The pH exceeds 7.0 within approximately 10 minutes of the start of the accident. This results in a long-term sump pH of approximately 7.88. Complete dissolution of the NaTB decahydrate occurs around 85 minutes; with the sump pH being approximately 7.93 at the start of recirculation.

The final case considered the baskets filled to the top (maximum height of 4.5 ft) and a bulk (manufactured) maximum density of 56 lbs/ft^3. In this configuration, the baskets would hold 486 ft^3 or 27,216 lbs of NaTB decahydrate. The pH exceeds 7.0 within approximately 10 minutes of the start of the accident. This results in a long-term sump pH of approximately 8.24. This amount of NaTB decahydrate fully dissolves in approximately 125 minutes, with the pH at the onset of recirculation being approximately 7.92.

Tables 1, 2, and 3 below provide the ranges of volume and concentration of borated sources evaluated for this modification and provide the calculated pH of each case.

Table 1

TS Limit Minimum Case (15,000 lb NaTB) Borated Water Sources and Resulting pHs

Source	Volume (ft^3)	Boron (ppmB)	Resulting pH / ppmB at Recirculation Start	Resulting Long-Term pH / ppmB
RCS	11399	1800	7.77 / 2871	7.69 / 2871
CFT	2300	2670		
M&ST	543	1800		
BWST	54153	2670		

M&ST – Makeup and Storage Tank

Table 2

Baskets Filled to 4.1 ft Case (21,561 lb NaTB) Borated Water Sources and Resulting pHs

Source	Volume (ft^3)	Boron (ppmB)	Resulting pH / ppmB at Recirculation Start	Resulting Long-Term pH / ppmB
RCS	11399	1800	7.93 / 3047	7.88 / 3047
CFT	2300	2670		
M&ST	543	1800		
BWST	54153	2670		

Table 3

Maximum Case (27,216 lb NaTB) Borated Water Sources and Resulting pHs

Source	Volume (ft^3)	Boron (ppmB)	Resulting pH / ppmB at Recirculation Start	Resulting Long-Term pH / ppmB
RCS	10142	0	7.92 / 2286	8.24 / 2776
CFT	1660	2270		
M&ST	0	0		
BWST	42256	2270		

3.1 Evaluation of Containment Free Volume, Heat Sink, and Fluid Inventory

The installation of large stainless-steel baskets filled with NaTB decahydrate results in a minor decrease in RB net free volume and an increase in the available heat sinks in the RB. The additional heat sinks and the reduction in net free volume were evaluated and determined to have negligible impact on the RB peak pressure and temperature calculations for LOCAs as well as the RB post-LOCA flood level. Subsequently, the installation and use of NaTB decahydrate baskets do not affect the post-accident RB pressure and temperature profiles used for environmental qualification analyses.

Elimination of the NaOH spray additive inventory would reduce the post-accident RB sump fluid inventory very slightly. RB water level and net free volume have been evaluated. Available net positive suction head (NPSH) calculated for the pumps taking suction from the RB sump (low head safety injection pumps and RB spray pumps) is slightly reduced but remains within acceptable limits. Similarly, plant hydraulic models and component erosive wear calculations remain unchanged. Acids generated during long-term core cooling increased insignificantly. Post-accident radiological doses with respect to applicable accident analyses were not affected by the decreased water inventory.

3.2 NaTB Decahydrate Effects on ECCS Strainer Blockage

NaTB decahydrate is predicted to result in the same precipitate formation with no adverse side effects as demonstrated by alternate buffer testing documented in Westinghouse WCAP-16596-NP, Revision 0, "Evaluation of Alternative Emergency Core Cooling System Buffering Agents" (Reference 3), and WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," (Reference 4).

As part of a PWROG chemical effects resolution effort, Westinghouse has evaluated several compounds as potential replacement buffers that would minimize the potential for chemical precipitate formation following a LOCA. The NaOH spray, reacting with aluminum in the RB, has the potential to produce chemical precipitates such as sodium aluminum silicate ($NaAlSi_3O_8$) and aluminum oxyhydroxide (AlOOH). The Westinghouse study determined that NaTB decahydrate produces less chemical precipitates and is an acceptable alternative for replacing NaOH.

The chemical effects debris load remains unchanged following installation and use of NaTB decahydrate because the WCAP-16530-NP (Reference 4) methodology treats NaOH and NaTB decahydrate equivalently with respect to precipitate formation. There are no changes to RB materials, insulations, or coatings, that could increase the strainer debris load. The NaTB baskets are constructed from stainless steel and thus do not increase strainer debris loads. Since the RB sump and RB Spray pH's used in the original NRC Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" (Reference 5) analysis bound the pH curves of the maximum and minimum NaTB decahydrate cases, no increase in chemical precipitate debris will occur. Therefore, there is no impact on the existing GSI-191 or NRC Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" (Reference 6), assessments completed by ANO-1.

3.3 Environmental Qualification

The Environmental Qualification (EQ) program for ANO-1 meets the requirements of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants." Equipment within the scope of this program has been evaluated for compliance with both NRC IE Bulletin No. 79-01B, "Environmental Qualification of Class 1E Equipment" (Reference 7) and 10 CFR 50.49. The current NaOH RB Spray additive system design renders the RB Spray solution alkaline while NaOH is discharged into the boric acid solution from the BWST at the RB Spray pump suctions. Equipment in the EQ program is qualified for a chemical spray with a pH range of 7.0 to 10.5.

With NaTB decahydrate pH control, the pH of RB Spray water during the injection phase could be as low as 4.8. During the recirculation phase, the pH will be maintained within a range of 7.0 to 8.5 under equilibrium conditions. During the transition from the injection phase to the recirculation phase, the RB Spray water pH could remain below 7.0 for a short period prior to complete mixing of the RB sump volume. The time period below a pH of 7.0 is related to the time between injection initiation and recirculation. As discussed previously, the RB sump pH analyses indicate that for all cases the pH increases to a value above 7.0 within approximately 10 minutes. This is well before the nominal time that recirculation is initiated which ranges between approximately 70 and 90 minutes.

The change to an acidic short-term RB injection spray for ANO-1 is consistent with the similar changes made for ANO-2 (References 1 and 2). The ANO-2 changes considered an injection spray with a pH as low as 4.4, which was acceptable since the majority of equipment degradation occurs during the post-LOCA recirculation phase. Since the ANO-1 lower pH value of 4.8 is bounded by the lower ANO-2 pH of 4.4, the conclusions for ANO-2 are also applicable for ANO-1.

Due to the timing sequence of the post-accident recovery, the majority of the equipment degradation from RB Spray occurs during the recirculation phase as stated above, when long-term core cooling is provided. Since the resulting pH level will be closer to neutral, post-LOCA corrosion of RB components will not be increased as a result of the proposed change.

The existing EQ limits for the ANO-1 RB spray, 15,000 ppmB and a pH of 10.5, still bound the long-term spray chemistry following the NaTB decahydrate modification. Post-LOCA temperatures, pressures, radiation levels, and humidity are unchanged. The post-LOCA water level decreases very slightly, but this alteration is conservative with respect to EQ effects because it reduces the amount of materials/components submerged by the sump fluid during recirculation.

3.4 Iodine Generation and Offsite Dose

Under LOCA conditions, buffering agents must be added to the RB Sump fluid that is recirculated by the ECCS to increase the coolant pH to greater than 7.0. Buffering agent addition is mainly required to reduce the release of iodine fission products from the coolant to the RB atmosphere as iodine gas. Thus, pH control is primarily an offsite dose control measure.

NaOH is used as the buffering agent at many plants, including ANO-1. The NaOH is stored in a tank and is discharged into the RB Spray system trains during LOCA response.

A Pressurized Water Reactor Owners Group (PWROG) program previously identified alternative buffering agents for use in the ECCS to raise the pH of the RB sump solution following a LOCA. The primary goal of the PWROG alternative buffering agent program was to identify suitable replacement buffers to minimize precipitate generation under post-accident conditions. The results of the candidate buffer testing indicated that an appropriate replacement for NaOH is NaTB decahydrate (Reference 3).

The proposed change replaces the addition of liquid NaOH to the RB Spray system with NaTB decahydrate, which will be stored in baskets on the lowest floor of the RB. As a result of this change, the initial ANO-1 RB Spray would consist only of a borated water solution from the BWST with a minimum pH of 4.87. As indicated in Standard Review Plan (SRP), Section 6.5.2, "Reactor Building Spray as a Fission Product Cleanup System" (Reference 8), fresh sprays (sprays with no dissolved iodine) are effective at scrubbing elemental iodine and thus a spray additive is unnecessary during the initial injection phase when the spray solution is being drawn from the BWST. Additionally, an iodine decontamination factor using an iodine partition factor of 3.29×10^4 was previously calculated, which remains constant since sump pH remains above 7.0. The calculated iodine decontamination factor is approximately 1000 and, in accordance with SRP Section 6.5.2, a bounding/limiting value of 200 was applied. Subsequently, iodine scrubbing is not impacted by the change in buffering agent.

As described in the SRP, elemental iodine can be scrubbed from the atmosphere with water at a low pH. This low pH is raised by the dissolution of the NaTB decahydrate during post-LOCA RB sump flooding to provide a higher pH during long-term core cooling. The acidic injection and spray remain only until recirculation is initiated; at this point, the fluid gathered around the RB sump strainers has dissolved most of the NaTB decahydrate and achieved a higher pH. The time history of the NaTB decahydrate dissolution was analyzed based on water level due to the borated water sources and flow rates given in the ANO-1 Safety Analysis Report (SAR) for a single failed ECCS train. For circumstances up to the large break LOCA and the minimum ECCS inventory for RB sump flooding, sufficient NaTB decahydrate dissolves to raise the pH above 7 before recirculation is initiated.

The current licensing basis for ANO-1 credits the Alternative Source Term (AST) in accordance with Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" (Reference 9), for evaluating the radiological consequences of a LOCA. The SRP and RG 1.183 indicate that if the sump water pH is 7.0 or greater, then a licensee does not need to evaluate re-evolution of iodines for dose consequences. In accordance with the current licensing basis, the dose analysis need not address iodine re-evolution, since a long-term sump water pH of 7.0 or greater is achieved prior to initiation of recirculation.

The change in the buffering agent from NaOH to NaTB decahydrate has a positive impact (closer to neutral pH) on the long-term RB sump water pH vs. time history. In addition, since the NaTB decahydrate baskets are sized to ensure a long-term sump water pH of 7.0 or greater, there is no impact on the current post-LOCA RB and ECCS leakage dose consequence models relative to iodine re-evolution. The calculated integrated iodine release for this pathway is bounded by the current analysis and, therefore, the current LOCA dose consequence analysis of record for ANO-1 remains valid for the NaTB decahydrate modification.

3.5 Acid Production

Acid production has been considered in the pH calculations. The strong acids of concern are hydrochloric acid resulting from cable degradation in high radiation fields and nitric acid generated due to radiolysis of the RB air and sump water, as described in NUREG/CR-5950, "Iodine Evolution and pH Control" (Reference 10). The maximum quantity of these acids generated during the 30-day duration post-LOCA was calculated to be 2979 mol. This quantity was based on the 30-day integrated beta and gamma dose values from a LOCA with conservative volumes of RB cable insulation and sump water. A time-dependent analysis at other times was not performed. The calculated RB sump water pH and the associated required mass of NaTB decahydrate incorporate the 30-day acid production as if the acid were produced in only two days (48 hours). This applies the entire 30-day acid load into the RB sump volume at a rate of 0.01724 mol/s for 48 hours and includes the acid effects on RB sump pH prior to recirculation. The calculated post-accident pH following the initiation of recirculation remains between 7.0 and 8.5, which meets the requirement of being greater than 7.0 and less than the ANO-1 maximum of 10.5. Thus, acid production is shown to be acceptable.

3.6 Corrosion Rates

Increasing the RB sump pH from the slightly acidic BWST value to a slightly alkaline value reduces the corrosion rates of most materials in the RB, most notably metallic structural members and components. The maximum ANO-1 calculated pH of 8.24 using NaTB decahydrate is significantly less than a pH of 10.5 used to determine material corrosion and hydrogen generation rates and less than the upper pH limit of 9.0 based on injection of NaOH at maximum concentration. Based on the similar pH conditions of the post-LOCA fluid between use of the existing NaOH system and the new NaTB decahydrate application, no increase in corrosion rates is expected.

3.7 Hydrogen Generation

ANO-1 hydrogen generation is associated with four different mechanisms. The four mechanisms are 1) metal-water reaction with fuel cladding, 2) entrained hydrogen in RCS water, 3) radiolytic decomposition of water, and 3) reaction of sump water with materials susceptible to corrosion (i.e. aluminum, copper, zinc). The metal-water reaction with the fuel cladding is unchanged along with the volume of RCS water that would release hydrogen. Additionally, hydrogen that is generated due to radiolysis is not affected since hydrogen generation assumptions were based on bounding radiation levels that are not changed by the use of the proposed buffering agent. The corrosion mechanism is based on a fixed quantity of materials that oxidizes to produce hydrogen. The amount of this material is unchanged by the application of the proposed buffering agent and is conservatively based on a pH of 10.5, which bounds the long-term pH with use of NaTB decahydrate. Thus, the assumed hydrogen generation remains unchanged.

3.8 Effects on TS Requirements and TS Bases Information

As stated in Section 2.4 of this letter, the removal of the NaOH additive system also results in the removal of the automatic ESAS features associated with the NaOH tanks two outlet motor operated valves (MOVs). This requires the references to actuation Channels 9 and 10 (associated with the two aforementioned MOVs) to be removed from TS 3.3.6, "Engineered Safeguards Actuation System (ESAS) Manual Initiation." The change from the current active NaOH additive system to the proposed passive NaTB decahydrate additive configuration eliminates all active failure modes that could be associated with the current system and, in this respect, is considered an enhancement.

The new proposed buffering agent TS requires the agent to be operable, which is verified by the two SRs discussed below. With the buffering agent inoperable, operability must be restored within 72 hours, consistent with the current Completion Time of the NaOH additive system. Although the RB Spray system remains available, the pH adjustment capability of the RB spray solution for corrosion protection and iodine retention enhancement is reduced or non-existent in this Condition. The 72-hour Completion Time takes into account the low probability of the worst-case DBA occurring during this period.

Failure to restore operability in this time frame will require the unit to be placed in Mode 3 within 6 hours, again consistent with the current NaOH additive system TS requirements. The Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

Proposed SR 3.6.6.1 requires the verification of a minimum volume of NaTB within each of the three baskets. This verification is necessary due to the possibility of leaking valves and components in the RB that could cause dissolution of the buffering agent during normal operation. The SR Frequency is controlled under the SFCP. The proposed SR is necessary to verify that a combined minimum volume of 308 ft^3 is contained in the buffering agent baskets. This requirement ensures that there is an adequate volume of buffering agent to adjust the pH of the post-LOCA sump fluid to a value ≥ 7.0. This information is included in the proposed TS Bases (reference Attachment 2 of this enclosure).

Proposed SR 3.6.6.2 requires a sample from each RB sump buffering agent basket to verify adequate pH adjustment of borated water. Testing must be performed to ensure the solubility and buffering ability of the buffering agent after exposure to the RB environment.

A representative sample of 2.69 ± 0.05 grams of buffering agent from one of the baskets in the RB is submerged in 1.0 ± 0.01 liter of water at a boron concentration of 2890 ± 30 ppm and at a temperature of 120 ± 5 °F. The solution is allowed to stand for 4 hours without agitation. The liquid is then decanted from the solution and mixed, the temperature adjusted to 77 ± 2 °F, and the pH measured. At this point, the pH must be ≥ 7.0. The representative sample weight is based on the minimum required buffering agent weight of 6804 kgs (15,000 lbs), which at a manufactured minimum density of 48.7 lbm/ft^3, corresponds to the minimum volume of 308 ft^3, and assumed post-LOCA borated water mass in the sump of approximately 4,070,000 lbm normalized to buffer a 1.0 liter sample. The boron concentration of the test water is representative of the maximum possible boron concentration corresponding to the calculated post-LOCA sump volume producing the lowest pH. 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 buffering agent to naturally diffuse through the sample solution. In the post-LOCA RB sump, rapid mixing would occur, significantly decreasing the actual amount of time before the required pH is achieved. This would ensure compliance with the Standard Review Plan requirement of a pH ≥ 7.0 by the onset of recirculation after a LOCA. This information is also included in the proposed TS Bases and is consistent with the test criteria of the ANO-2 buffering agent TS, adjusted for ANO-1 values.

A markup of the TS Bases associated with the two TSs proposed for amendment in this request are included in Attachment 2 of this enclosure for information only. A markup of other TS Bases that may make mention of the NaOH additive system is not included in this submittal since the respective TSs are not proposed for change. Nevertheless, all affected TS Bases will be revised as necessary following approval of and upon implementation of this amendment request in accordance with ANO-1 TS 5.5.16, "Technical Specifications (TS) Bases Control Program." This is considered a regulatory commitment and is included in Attachment 4 of this enclosure.

Conclusion

The proposed replacement of NaOH with NaTB decahydrate has less potential for undesirable chemical effects, while maintaining an acceptable long-term sump pH range to minimize radioactivity releases and corrosion of RB materials. The proposed change would not have adverse effects on the radiological analysis, hydrogen generation, or the functional capability of RB systems, structures, and components following a postulated LOCA.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

Entergy proposes to replace the existing NaOH RB Spray Additive system with a passive RB sump buffering agent containing NaTB decahydrate. The new NaTB decahydrate additive will continue to support control of post-accident RB sump pH and maintain effective iodine removal from the RB atmosphere, which is currently provided by the NaOH additive.

Applicable regulation and Atomic Energy Commission (AEC) General Design Criterion (GDCs) related to the functional changes to the RB Spray Additive system are listed below.

GDC 19, “Control Room,” requires adequate radiation protection be provided to permit access and occupancy of the Control Room under accident conditions without personnel receiving radiation exposure in excess of 5 rem TEDE, for the duration of the accident.

GDC 20, “Protection System Functions,” requires, in part, the automatic initiation of appropriate systems to assure specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences.

GDC 35, "Emergency Core Cooling," relates to the safety system function to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

GDC 38, "Containment Heat Removal," relates to the capability of the RB system to accomplish its safety function.

GDC 41, “Containment Atmosphere Cleanup,” requires systems to control fission products, hydrogen, oxygen, and other substances that may be released into the RB to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the RB atmosphere following postulated accidents to assure that RB integrity is maintained.

GDC 42, “Inspection of Containment Atmosphere Cleanup Systems,” requires the RB atmosphere cleanup systems to be designed to permit appropriate periodic inspection of important components, such as filter frames, ducts, and piping to assure the integrity and capability of the systems.

GDC 43, “Testing of Containment Atmosphere Cleanup Systems,” requires the RB atmosphere cleanup systems to be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems.

10 CFR 50.44, "Combustible Gas Control for Nuclear Power Reactors," relates to the requirement for PWR plants to have the capability for ensuring a mixed atmosphere so that the concentration of combustible gasses in the RB is below a level that would support combustion or detonation that could cause loss of RB integrity.

10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," requires qualification of electrical equipment with respect to environmental conditions at the location where the equipment must perform its safety function.

10 CFR 50.67, "Accident Source Term," provides criteria for evaluating the consequences of applicable design basis accidents.

Industry standards and NRC guidance documents were also considered with respect to the proposed change including:

NRC Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," dated September 14, 2001.

NRC Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004.

NRC NUREG-0800, Revision 2, "Standard Review Plan," Section 6.2.2, "Containment Heat Removal Systems," indicates that the RB Spray system should be designed to effectively remove fission products from the containment atmosphere.

NRC NUREG-0800, Revision 2, "Standard Review Plan," Section 6.5.2, "Containment Spray as a Fission Product Cleanup System", provides guidance for determining the fission product removal effectiveness of the RB spray and additive (or pH control) systems.

NRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," provides criteria for evaluating the consequences of applicable design basis accidents and indicates that analyses should consider iodine re-evolution if the RB sump liquid pH is not maintained at 7.0 or greater.

NRC NUREG/CR 5732, "Iodine Chemical Forms in LWR Severe Accidents," contains information with respect to the benefit of RB sump pH control during accident conditions.

NRC NUREG/CR-5950, "Iodine Evolution and pH Control," also contains information with respect to the benefit of RB sump pH control during accident conditions.

NRC IE Bulletin No. 79-01B, "Environmental Qualification of Class 1E Equipment," contains information intended to support equipment functionality under postulated accident conditions.

Note that ANO-1 was not licensed to the 10 CFR 50, Appendix A, GDC. ANO-1 was originally designed to comply with the 70 "Proposed General Design Criteria for Nuclear Power Plant Construction Permits," published in July 1967. However, the ANO-1 SAR provides a comparison with the AEC GDC published as Appendix A to 10 CFR 50 in 1971.

The use of a passive NaTB decahydrate spray additive system in lieu of the current NaOH spray additive system, including the associated planned changes and modifications, conforms to applicable industry standards as described herein and, therefore, the proposed change does not affect compliance with regulations (including the aforementioned GDCs) or guidance and will ensure that the lowest functional capabilities or performance levels of equipment required for safe operation are met.

4.2 Precedent

A license amendment request (LAR) to replace NaOH with TSP at ANO-2 was submitted to the NRC in an application dated May 18, 1998 (Reference 11) and approved on December 23, 1998 (Reference 1). A LAR was later submitted to replace TSP with NaTB decahydrate at ANO-2 in an application dated October 5, 2007 (Reference 12) and approved on March 31, 2008 (Reference 2).

4.3 No Significant Hazards Consideration Analysis

Entergy Operations, Inc. (Entergy) requests a revision to Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specification (TS) 3.6.6, "Spray Additive System," to support replacing the existing sodium hydroxide (NaOH) additive system with a passive additive system containing sodium tetraborate (NaTB) decahydrate. The proposed change is an enhancement since the new NaTB decahydrate system will require no active features in order to fulfill the intended safety function.

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

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

   Response: No

   The use of NaTB decahydrate in lieu of NaOH does not involve an increase in probability of a previously evaluated accident because the Reactor Building (RB) spray additive is not an initiator of any analyzed accident. The NaTB decahydrate would be stored and delivered by a passive method that does not have the potential to affect plant operations. Therefore, the change in additive, including removal of NaOH equipment from service, would not result in any failure modes that could initiate an accident.

   The RB spray additive is used to mitigate the long-term consequences of a loss of coolant accident (LOCA). The use of NaTB decahydrate as an additive in lieu of NaOH does not involve an increase in the consequences of a previously evaluated accident because the amount of NaTB decahydrate specified in the proposed TS would result in a sump pH of 7.0 or greater, consistent with the current licensing basis. This pH is sufficient to achieve long-term retention of iodine by the RB sump fluid and associated RB Spray system for the purpose of reducing accident-related radiation dose following a LOCA.

   Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

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

   Response: No

   Regarding the proposed use of NaTB decahydrate in lieu of NaOH, the NaTB decahydrate would be stored and delivered by a passive method that does not have potential to affect plant operations. The assumed amount of hydrogen generation is not impacted by the change. The use of the proposed passive NaTB decahydrate additive system does not impact RB sump debris acceptance criteria. No new failure mechanisms, malfunctions, or accident initiators are introduced by the proposed change.

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

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

   Response: No

   Since the quantity of NaTB decahydrate specified in the proposed amended TS would reduce the potential for undesirable chemical effects while achieving radiation dose reductions, provide corrosion control, and result in hydrogen generation effects that are comparable to NaOH, the proposed change does not involve a significant reduction in a margin of safety. The primary function of an additive is to reduce long-term LCOA dose consequences by controlling the amount of iodine fission products retained in the RB atmosphere. Because the proposed amended TS would achieve a sump pH of 7.0 or greater using NaTB decahydrate, accident related dose consequences are not impacted. In addition, the use of NaTB decahydrate reduces the potential for undesirable chemical effects that could interfere with recirculation flow through the sump strainers.

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

Based on the above, Entergy concludes that the proposed change 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.

4.4 Conclusion

In conclusion, based on the considerations discussed above, (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 or to the health and safety of the public.

5.0 ENVIRONMENTAL EVALUATION

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 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 effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed change 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 change.

5.0 REFERENCES

1. NRC letter to Entergy Operations, Inc. (Entergy), "Issuance of Amendment No. 194 to Facility Operating License No. NPF-6 – Arkansas Nuclear One, Unit No. 2 (TAC No. MA1934)," (2CNA129804) (ML021560287), dated December 23, 1998.

2. NRC letter to Entergy, "Arkansas Nuclear One, Unit No. 2 – Issuance of Amendment Re: Technical Specifications 3.6.2.2, 'Containment Sump Buffering Agent trisodium Phosphate (TSP)' (TAC No. MA6933)," (2CNA030809) (ML080720526), dated March 31, 2008.

3. Westinghouse WCAP-16596-NP, Revision 0, "Evaluation of Alternative Emergency Core Cooling System Buffering Agents," dated July 2006.

4. Westinghouse WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," dated March 2008.

5. NRC Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," (ML17214A813), dated September 14, 2001.

6. NRC Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," (ML042360586), dated September 13, 2004.

7. NRC IE Bulletin No. 79-01B, "Environmental Qualification of Class 1E Equipment," (ML7910250528), dated January 14, 1980.

8. NRC NUREG-0800, Revision 2, "Standard Review Plan," (ML052070474), dated December 1988.

9. NRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," (ML003716792), dated July 2000.

10. NRC NUREG/CR-5950, "Iodine Evolution and pH Control," (ML063460464), dated December 1992.

11. Entergy letter to NRC, "Proposed Technical Specifications Change Concerning Spray Additive," (2CAN059806), dated May 18, 1998.

12. Entergy letter to NRC, " Technical Specification Change Request Associated with Replacement of Containment Sump Buffer," (2CAN100703) (ML072890085), dated October 5, 2007.

13. NRC NUREG/CR 5732, "Iodine Chemical Forms in LWR Severe Accidents," (ML003726825), dated April 1992.