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10 CFR 50.90

1CAN082005

August 27, 2020

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

Subject: Additional Information Related to License Amendment Request to Replace the 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), as supplemented by letter dated July 21, 2020 (Reference 2), 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, the NRC determined additional information was required to complete the acceptance review process. The requested additional information is included in the attached enclosure. This information does not impact the no significant hazards consideration provided in the original amendment request (Reference 1).

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 August 27, 2020.

Respectfully,

ORIGINAL SIGNED BY RON GASTON

Ron Gaston

RWG/dbb

Enclosure: Additional Information Related to the Replacement of Reactor Building Spray Sodium Hydroxide Additive with a Passive Reactor Building Sump Buffering Agent Sodium Tetraborate

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.

2. Entergy letter to NRC, *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 (1CAN072001) (ML20203M182), dated July 21, 2020.

3. NRC email to Entergy, *ANO-1 Final RAI RE: LAR to Replace RB Spray NaOH Additive (EPID L-2020-LLA-0036),* (1CNA082001) (ML20223A365), dated August 10, 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

1CAN082005

Additional Information Related to the Replacement of Reactor Building Spray Sodium Hydroxide Additive with a Passive Reactor Building Sump Buffering Agent Sodium Tetraborate

ADDITIONAL INFORMATION RELATED TO THE REPLACEMENT OF REACTOR BUILDING SPRAY SODIUM HYDROXIDE ADDITIVE WITH A PASSIVE REACTOR BUILDING SUMP BUFFERING AGENT SODIUM TETRABORATE

By letter dated February 24, 2020 (Reference 1), as supplemented by letter dated July 21, 2020 (Reference 2), 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. The NRC issued a request for additional information on August 10, 2020 (Reference 3), with a required response due September 9, 2020. The requested supplemental information is included below.

<u>Request for Additional Information</u>

To complete its evaluation of whether, following a DBA LOCA, the sump water will achieve a pH of at least 7.0 by the time spray recirculation begins, and then maintain the pH at or above 7.0, the NRC staff requests the following information:

1. Maximum Boron Content in Reactor Coolant System (RCS) and Makeup and Storage Tanks (M&ST)

   As described in the LAR and the referenced calculation CALC-19-E-0009-02, Rev. 0, "ANO-1 Alternate Buffer Evaluation," the maximum boron concentrations for the reactor coolant system (RCS) and makeup and storage tanks (M&ST) are assumed to be 1800 parts per million (ppm) boron. However, the boron concentration for these systems is not limited by the plant Technical Specifications (TSs). Without a limit on the maximum boron concentration for these systems, it may be possible to operate at higher boron concentrations, which could result in a lower pH after a DBA LOCA. The amount of buffer (sodium tetraborate) stored in containment would be fixed as per proposed TS 3.6.6, "Reactor Building (RB) Sump Buffering Agent."

   a. Given that there is no upper limit in the TSs on boron concentration in the RCS and M&ST, provide the range of maximum RCS and M&ST boron concentrations considered for the post-LOCA pH calculation, and the basis for those values.

   b. Based on Item a. above, describe how much the maximum RCS and M&ST boron concentrations affect the calculated post-LOCA pH.

   c. Provide the basis for the RCS and M&ST value of 1800 ppm used in the post-LOCA pH calculations supporting the use of sodium tetraborate pH buffer proposed in the LAR.

Entergy Response

a. Reload Analyses were used to determine the RCS (and consequently, the M&ST) boron concentrations, which depict the core boron concentrations during start-up and end of cycle operation as a graph of boron concentration vs. time. Values for specific points of interest are also tabulated. For example, for Cycle 29, the critical boron at hot zero power (HZP) at the beginning of cycle (BOC) was 1843 ppm and at hot full power (HFP) was 1629 ppm with Group 8 control rods inserted. At the end of cycle (EOC) with the control rods out, the RCS boron concentration at HFP was 0 ppm.

Other startups following the previous five refueling outages indicated a BOC HFP boron concentration ranging from 1564 to 1836 ppm.

The M&ST boron concentration was set to equal that of the RCS since these two components share the same fluid inventory. During normal operation, the boron concentration of the RCS, and thus the M&ST, decreases from the initial start-up values shown in the reload analyses, and there are no other sources of boron that could increase the coolant's boron concentration; therefore, choosing a value that is at the beginning of core life with a high core boron concentration curve is a reasonable, conservative evaluation input.

b. Sensitivity cases were run to demonstrate the effect of increasing the RCS and M&ST boron concentration on the pH results. Keeping all other inputs and methods the same as described in CALC-19-E-0009-02 but changing the boron concentration of those two inputs, the following results were obtained:

Table 1

Sump pH Sensitivities at various RCS and M&ST Boron Concentration

	At 10 Minutes			
	RCS and M&ST Boron Concentration (ppm)			
	1800	*2400*	*3000*	*3600*
TS Case, pH	7.21	7.16	7.11	7.06
Administrative Limit Case, pH	7.21	7.16	7.11	7.06
Maximum pH Case, pH*	N/A	N/A	N/A	N/A

	At Recirculation			
	RCS and M&ST Boron Concentration (ppm)			
	1800	*2400*	*3000*	*3600*
TS Case, pH	7.77	7.75	7.74	7.73
Administrative Limit Case, pH	7.93	7.92	7.91	7.89
Maximum pH Case, pH*	N/A	N/A	N/A	N/A

	At 30 Days			
	RCS and M&ST Boron Concentration (ppm)			
	1800	*2400*	*3000*	*3600*
TS Case, pH	7.69	7.67	7.66	7.65
Administrative Limit Case, pH	7.88	7.86	7.85	7.84
Maximum pH Case, pH*	N/A	N/A	N/A	N/A

* The Maximum pH Case has the RCS boron concentration set to 0 ppm and the M&ST fluid volume set to 0 ft^3; therefore, the sensitivity results do not apply.

The sensitivity results show that the pH values in all cases still meet the requirement of the sump fluid being greater than pH 7.0 at recirculation even when high RCS and M&ST boron concentrations are considered.

c. The maximum RCS and M&ST boron concentrations analyzed in the alternate buffer evaluation are reflected in both the TS and Administrative Limit cases of CALC-19-E-0009-02. These cases applied a value of 1800 ppm for both the RCS and M&ST inventories. The 1800 ppm value was taken from the most recent Cycle 29 reload analysis as a bounding value greater than the BOC HFP value of 1629 ppm.

This value of 1800 ppm is a reasonable, conservative interpretation of the core boron data since this reload cycle is the most recent, and the chosen value of 1800 ppm is near or greater than the concentrations measured during BOC HFP of previous reload cycles. Furthermore, using a value from the BOC when the core boron concentration is the greatest ensures a higher concentration is used in the analysis than what is expected to exist in the RCS and M&ST during operation.

2. Evaluation of Strong Acids

SRP Section 6.5.2, sub-section III.4.C.ii, "Elemental iodine removal during recirculation of sump solution," states that the NRC staff should consider all known sources of acids in a post-accident containment environment. Following a DBA LOCA, generation of strong acids (i.e., hydrochloric and nitric acids) is predicted due to degradation of cable insulation and radiolysis of nitrogen and water. Section 3.5, "Acid Production," of the LAR describes the 30-day production of hydrochloric and nitric acids.

During the audit of calculation CALC-19-E-0009-02, Rev. 0, the NRC staff reviewed the licensee's method for determining the impact of these strong acids on the sump pH. However, it was not clear that the methodology accounts for the degree of dissociation of strong acids and weak bases, as strong acids dissociate completely, while weak bases do not.

Clarify how the impact of strong acids is accounted for in the sump pH calculation.

Entergy Response

Since the mixing reaction is simplified by assuming all components of the fluid mix instantly and completely, the two major concerns are the degree of reactivity and the kinetics (speed) of reactions. Although there are specific examples which can be found, in general, weak acids or bases react quite rapidly with either weak or strong examples of their opposites (e.g., a weak acid will react quickly with either a weak or strong base). Thus, the kinetics of reaction are not associated with the designation of "strong" and "weak". Similarly, a weak acid will react completely with any available strong base and vice versa, and the extent of the reaction is determined only by the relative amounts of each. The reaction between "strong" and "weak" species is complete to the extent that one of the species is consumed by the one in excess.

The current case of two strong acids (hydrochloric acid – HCl and nitric acid – HNO_3) reacting with a relatively strong base (sodium tetraborate) is straightforward and takes precedence over any reaction with dissociated boric acid because the equilibrium with boric acid can only be forced backwards to a very limited extent. If there is any excess strong acid remaining after consuming the sodium tetraborate, this reaction (forcing dissociated boric acid backwards to form more un-dissociated boric acid) will occur.

If all strong acid is consumed, then any remaining sodium tetraborate will react with boric acid to form more dissociated boric acid (thus forming more borate ion) and hydrogen tetraborate (another weak acid).

For example, considering the case when the concentration of strong acid in solution is greater than the concentration of tetraborate and the concentration of tetraborate is less than 10% of that of boric acid, the pH is essentially determined only by the boric acid-borate equilibrium and how much it is shifted by the excess strong acid. The tetraborate-hydrogen tetraborate equilibrium can be neglected because it will have a negligible impact, and only the excess strong acid needs to be considered because the remainder is essentially consumed by the sodium tetraborate.

For conservatism, the entire 30-day strong acid inventory was introduced into the model linearly over the first 48 hours. This application decreases the pH of the sump fluid when it is most vulnerable to acidic conditions due to the amount of sodium tetraborate that has dissolved at the early stages prior to recirculation.

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.

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