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2CAN061002

June 24, 2010

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

SUBJECT: Request for Additional Information
Technical Specification Changes and Analyses Relating to
Use of Alternative Source Term
Arkansas Nuclear One, Unit 2
Docket No. 50-368
License No. NPF-6

- REFERENCES:
1. Entergy letter to the NRC, dated March 31, 2010, "License Amendment Request Technical Specification Changes and Analyses Relating to Use of Alternative Source Term" (2CAN031001)
 2. Email from Kaly Kalyanam (NRC) to Robert W. Clark (Entergy), dated May 25, 2010, "Request for Additional Information on the AST LAR - ME3678"
 3. Entergy letter to the NRC, dated October 5, 2007, "License Amendment Request Technical Specification Change Request Associated with Replacement of Containment Sump Buffer" (2CAN100703)
 4. Entergy letter to the NRC, dated February 19, 2008, "License Amendment Request Replacement of Containment Sump Buffer Request for Additional Information" (2CAN020802)
 5. NRC letter to Entergy dated March 31, 2008, "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. MD6933)" (2CNA030809)

Dear Sir or Madam:

With Reference 1, Entergy Operations, Inc. (Entergy) submitted a request to change the Technical Specifications (TSs) for Arkansas Nuclear One, Unit 2 (ANO-2). In particular the amendment would modify the TS requirements related to the use of an alternate source term associated with accident offsite and control room dose consequences.

During the review of the material provided in Reference 1, the NRC determined that additional information was required to complete the Staff's evaluation of the Reference 1 request. In Reference 2, the NRC requested Entergy to respond to the requests for additional information (RAIs). Attached to this submittal are the RAIs included in Reference 2 and Entergy's response.

It should be noted that Entergy has changed the buffering agent for ANO-2 as presented in Reference 3. One important factor associated with the buffering agent change to sodium tetraborate (NaTB) was the post accident pH in the sump. An RAI that is very similar to the one in Reference 2 was responded to in Reference 4. The following was stated in the safety evaluation report presented in Reference 5:

Based on information provided by licensee's letter dated February 19, 2008, the NRC staff performed an evaluation to confirm the licensee's pH calculations. The NRC staff reviewed the licensee's methodology, assumptions, and performed hand calculations to verify the resulting pH value after 30 days. The NRC staff concluded that the licensee's methodology and calculations are conservative. The NRC staff's independent verification demonstrated the containment sump pH would remain greater than or equal to 7 for at least 30 days post-LOCA with the quantities of NaTB described above.

This letter contains no new commitments.

If you have any questions or require additional information, please contact David Bice at 479-858-5338.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 24, 2010

Sincerely,

Original signed by K. T. Walsh

KTW/rwc

Attachment: Response to Request for Additional Information Related to the Use of Alternative Source Term (AST)

cc: Mr. Elmo E. Collins
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Attachment to

2CAN061002

**Response to Request for Additional Information
Related to the Use of Alternative Source Term (AST)**

**Response to Request for Additional Information
Related to the Use of Alternative Source Term (AST)**

1. Describe the methodology used to verify that the minimum possible post-LOCA sump pH remains greater than 7.0. Specifically, please describe how the following parameters were accounted for in the calculation.

a. What is the maximum, beginning of cycle, boron concentration in the reactor coolant and borated water storage tank?

The maximum allowable Reactor Coolant System boron concentration during a fuel cycle is 2000 parts per million (ppm). The maximum allowable boron concentration in the refueling water tank (RWT) (this is the same as a borated water storage tank) is 3000 ppm per Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specification (TS) 3.5.4 (Reference 1). In addition, it should be noted that the minimum post-Loss of Coolant Accident (LOCA) sump pH calculation includes consideration of the maximum boron concentrations contained in the safety injection tanks (3000 ppm) and the boric acid makeup tank (6125 ppm).

b. What is the minimum volume of water assumed in the calculation of post-LOCA sump pH?

The calculation of post-LOCA sump pH assumed a minimum volume of water of 135,174,893 in³, or ~78,226.21 ft³.

c. What is the minimum quantity of buffering agent contained in the baskets?

15,000 pounds mass (lb_m) is the minimum quantity of buffering agent contained in the ANO-2 baskets. This is based on the ANO-2 TS 3.6.2.2 minimum requirement of 308 ft³ and a minimum sodium tetraborate (NaTB) density of 48.7 lb_m/ft³.

d. What is the buffering agent used at ANO-2 (trisodium phosphate or sodium tetraborate)?

ANO-2 uses sodium tetraborate.

e. What assumptions are made for the dissolution time of the buffering agent?

The ANO-2 post-LOCA pH calculation assumes the submerged portions of the NaTB in the baskets, which increases with time until the baskets are completely submerged, dissolve into the sump solution at a constant rate of 1.014 lb_m/ft²-min. This dissolution rate was calculated by multiplying the trisodium phosphate (TSP) dissolution rate of 0.7 lb_m/ft²-min provided in WCAP-11611 (Reference 2) by the dissolution time ratio of TSP-to-NaTB at 200°F (i.e. 42 seconds / 29 seconds) given in WCAP-16596-NP

(Reference 3). No credit was taken for dynamic flow. In addition, only the surface area of the four sides of the NaTB baskets is assumed to be exposed to the sump solution.

- f. **Describe the analysis used to determine strong acid concentrations in the sump for a period of 30 days post-LOCA. Include a description of the calculations for hydrochloric acid, generated by radiolytic decomposition of Hypalon cable insulation, and nitric acid, produced by irradiation of water and air in the containment.**

The analysis of the strong acid concentrations in the sump utilizes a conservative calculation of the total mass of cable jacket and filler materials in the ANO-2 containment to calculate the amount of hydrochloric (HCl) acid produced from exposure to both beta and gamma radiation. This approach is conservative since some cable is located in conduit and shielded from beta radiation. In addition, the filler materials do not contain chlorine. The analysis uses the total integrated 30-day post-LOCA beta and gamma doses in the containment atmosphere to calculate the total moles of HCl acid produced from the cable.

To calculate the total moles of nitric acid produced by irradiation of water and air in the containment post-LOCA, the analysis uses the total integrated 30-day gamma dose in the containment sump.

Irradiation of the cable is assumed to produce $4.6E-4$ moles of HCl acid per lb_m -megarad of exposure and irradiation of the sump water produces $7.3E-6$ moles of nitric acid per liter-megarad of exposure, consistent with NUREG/CR-5950 (Reference 4).

Using the above approach, a total of 3,473.6 moles of HCl acid and 147.1 moles of nitric acid are calculated to form in the ANO-2 containment sump during the 30-day post-LOCA period.

Given that the rate of acid generation in the sump is unknown, the analysis of the strong acid concentrations assumes that the total amount of acid generated during the 30-day accident is present in the sump instantaneously at the beginning of the accident. This assumption is extremely conservative, if a time-dependent sump pH profile is desired. However, the intent of the calculation was to show that the sump pH reaches, within a reasonable amount of time, then remains at or above 7.0 in the presence of the strong acids and for this purpose, the method was adequate. For comparison, the response to question 3 below also includes the time-dependent sump pH profile for this case.

2. How do the calculations for the proposed AST sump pH analysis differ from the previous calculation of sump pH?

No sump pH calculations were performed specifically for the AST analyses. Rather, the AST analyses utilize the results provided in the existing calculation of sump pH. However, the time at which the sump pH is assumed in the AST analyses to reach 7.0 varies slightly from the results contained in the existing sump pH calculation.

The existing sump pH calculation assumes a total Emergency Core Cooling System flow rate during injection of 16,450 gpm and a maximum RWT volume of 503,300 gallons to calculate a time to recirculation of 30.6 minutes. The AST analyses assume a total injection flow rate of 14,250 gpm and the minimum RWT volume of 384,000 gallons to calculate a time to recirculation of 26.95 minutes, consistent with the current, TID-based dose analysis-of-record (AOR). Also, consistent with the current AOR, the AST analyses “round down” the assumed time to recirculation to 26 minutes. This approach is conservative for dose analyses, because Engineered Safety Feature leakage during recirculation consequently starts sooner.

The AST analyses then use the time between start of recirculation and the time for the sump pH to reach 7.0 from the existing sump pH calculation to determine the time in the dose analyses that the sump pH is assumed to be below 7.0. From the sump pH profile provided in response to question 3 below, the time to reach a pH of 7.0 is determined by interpolating between the 30.60 and 45.83 minute time steps. The interpolation yields a pH of 7.0 at 41.38 minutes, or 10.78 minutes following the start of recirculation. The AST dose analyses conservatively round this value up to 11 minutes.

Given the pH value of 6.874 at the onset of recirculation is very near 7.0 and the 11 minute duration that the sump pH is below 7.0 is relatively short, the potential for re-evolution of elemental iodine is not high. However, the potential impact of re-evolved elemental iodine transferring to the containment atmosphere and escaping via the containment leakage pathway was still considered and treated in the following manner. During the 11 minute time frame when pH is less than 7.0, the elemental iodine spray removal coefficient was set to 0, thereby preventing the removal of containment elemental iodines by containment spray. The contribution to the overall doses of the elemental iodines not removed due to the assumed lack of containment spray flow during this time frame more than offsets the contribution to the overall doses of any re-evolved elemental iodine.

3. Provide the time dependant sump pH profile for the full duration of the LOCA analysis.

The time-dependant sump pH profile, in tabular form, for the full duration of the LOCA analysis follows:

Time (min)	Minimum Sump pH	Time (min)	Minimum Sump pH
0.23	5.160	60.00	7.116
0.58	5.372	65.00	7.116
1.25	5.692	70.00	7.116
2.50	5.994	75.00	7.116
3.00	6.024	100.00	7.115
5.00	6.283	125.00	7.114
6.67	6.380	145.83	7.113
10.00	6.574	171.67	7.112
13.33	6.681	191.67	7.112
15.00	6.698	216.67	7.111
20.83	6.829	241.67	7.110
25.00	6.839	766.67	7.104
30.60	6.874	7166.67	7.104
45.83	7.052	14333.33	7.104
50.00	7.098	29166.67	7.104
55.00	7.117	43200.00	7.104

The above table was utilized for the AST analyses and does not include the effects of strong acid generation, which is insignificant during the initial 45 minutes of the accident due to limited radiation exposure during that time and subsequent delays in cable degradation and acid transport to the sump. The time-dependant sump pH profile, accounting for the effect of 30 days of strong acid generation being instantaneously present in the sump at the start of the LOCA, is provided below and shows that after the sump pH reaches 7.0, it remains at or above 7.0 for the duration of the accident. The profile further shows that even in this additional scenario, the sump pH would be approximately 6.974 (or essentially 7.0) at 11 minutes after the start of recirculation.

Time (min)	Minimum Sump pH	Time (min)	Minimum Sump pH
0.23	5.160	60.00	7.012
0.58	5.372	65.00	7.012
1.25	5.692	70.00	7.012
2.50	5.994	75.00	7.012
3.00	6.024	100.00	7.011
5.00	6.283	125.00	7.010
6.67	6.380	145.83	7.009
10.00	6.574	171.67	7.009
13.33	6.681	191.67	7.008
15.00	6.698	216.67	7.007
20.83	6.829	241.67	7.006
25.00	6.839	766.67	7.000
30.60	6.874	7166.67	7.000
45.83	7.013	14333.33	7.000
50.00	7.013	29166.67	7.000
55.00	7.013	43200.00	7.000

References

1. ANO-2 Technical Specifications
2. WCAP-11611, "Methodology for Elimination of the Containment Spray Additive," March 1988.
3. WCAP-16596-NP, Rev. 0, "Evaluation of Alternative Emergency Core Cooling System Buffering Agents," July 2006.
4. NUREG/CR-5950, ORNL/TM-12242, "Iodine Evolution and pH Control," Oak Ridge National Laboratory.