Omaha Public Power District
444 South 16th Street Mall
Omaha, Nebraska 68102-2247
402/636-2000

January 3, 1996
LIC-95-0240

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

Reference: Docket No. 50-285

Subject: Licensee Event Report 95-008 Revision 00 for the Fort Calhoun Station

Please find attached Licensee Event Report (LER) 95-008 Revision 00 dated January 3, 1996. This report is being submitted pursuant to 10 CFR 50.73(a)(2)(ii). If you should have any questions, please contact me.

Sincerely,

T. L. Patterson
Division Manager
Nuclear Operations

TLP/epm

Attachment

c: Winston and Strawn
L. J. Callan, NRC Regional Administrator, Region IV
L. R. Wharton, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector
INPO Records Center

IE22
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NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 4/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO THE INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of

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TITLE (4)
Inadequate Trisodium Phosphate in Containment Due to Calculational Error

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
12	04	95	95	-- 008 --	00	01	03	96	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: (Check one or more) (11)					
POWER LEVEL (10)	100	20.2201(b)	20.2203(a)(2)(v)	50.73(a)(2)(i)	50.73(a)(2)(viii)		
		20.2203(a)(1)	20.2203(a)(3)(i)	X 50.73(a)(2)(ii)	50.73(a)(2)(x)		
		20.2203(a)(2)(i)	20.2203(a)(3)(ii)	50.73(a)(2)(iii)	73.71		
		20.2203(a)(2)(ii)	20.2203(a)(4)	50.73(a)(2)(iv)	OTHER		
		20.2203(a)(2)(iii)	50.36(c)(1)	50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A		
		20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)			

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Scott A. Lindquist, Shift Technical Advisor	(402) 533-6829

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On December 4, 1995, with the plant operating at 100% power, it was determined that at the beginning of the last several plant operating cycles the amount of Trisodium Phosphate (TSP) available in the containment was not sufficient to neutralize the post accident containment sump water to a pH of 7.0. The USAR specifically states that a post accident containment sump pH of 7.0 will minimize the potential for failure of safety related equipment in containment, by mitigating the potential for chloride induced stress corrosion cracking. Beginning of cycle boric acid concentrations in the Reactor Coolant System along with allowed limits in the Boric Acid Storage Tanks, Safety Injection Tanks, and Safety Injection and Refueling Water Tank have resulted in conditions where the plant could not have achieved a post accident sump pH of 7.0.

This condition resulted due to errors in the original calculations for the amount of TSP required in containment and an inadequate questioning attitude by nuclear organization personnel when addressing this issue.

Corrective actions include the administrative controls implemented to ensure that the quantity of TSP in containment is adequate for current plant conditions, revising the appropriate calculations for future operating cycles, the addition of TSP to the containment and a new Condition Reporting system that was implemented in September of 1995.

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BACKGROUND

Following a Design Basis Loss of Coolant Accident (LOCA), the Containment Spray (CS) system actuates to limit containment atmospheric pressure and temperature increases. The CS pumps discharge borated water from the Safety Injection and Refueling Water Storage Tank (SIRWT) to the spray headers and nozzles located near the containment dome. The water introduced into the containment from the CS system drains down into the containment sump where it will mix with leakage from the Reactor Coolant System (RCS). When a SIRWT low level signal initiates a Recirculation Actuation Signal (RAS), the CS and Safety Injection (SI) pumps suction switches from the SIRWT to the containment sump. The fluid discharged by the CS and SI pumps, while the pump suction is still from the SIRWT, consists of a borated water mixture with a pH of approximately 4.5 to 5.5. Boric acid solutions with a pH in this range have been shown to induce Chloride Stress Corrosion Cracking (SCC) in some metals used in plant systems in the containment. To minimize the possibility of failure of safety related equipment due to SCC, Trisodium Phosphate Dodecahydrate (TSP) is stored in the containment sump in mixing baskets. The TSP will mix with water from the CS pumps, as well as the water draining from the reactor coolant system leak (including the fluid pumped by the SI system into the RCS) into the containment sump area. The amount of TSP in the containment sump was intended to have been calculated to ensure that the resulting fluid mixture has a pH of no less than 7.0, but, no greater than 7.5.

The TSP is stored in three stainless steel wire mesh baskets located in the containment on the basement level near the outer wall. Related to the amount of TSP stored in the baskets the Fort Calhoun Station Updated Safety Analysis Report (USAR) Section 4.4.3, in the third paragraph, states that:

"Each basket contains approximately 20 cu. ft. of TSP. Sampling has determined that the average density of TSP is approximately 68.5 lb/ft^3. The total mass of TSP in containment is calculated to be approximately 4206 lbs. Based on the volume and concentration of boric acid solution, approximately 2108 lbs. of TSP is required to achieve a pH of 7.0 or greater. The allowable supply of 4206 lbs. of TSP represents an excess of 2098 lbs. over that needed to maintain the minimum pH. A minimum quantity of 40 cu. ft. or approximately 2740 lbs. of TSP has been established to assure ample supply for boric acid neutralization. The minimum amount specified represents an excess of approximately 23% over that needed to meet the calculated minimum requirements for TSP."

Fort Calhoun Station Technical Specification 3.6(2)d. provides the testing requirements for the TSP. This Technical Specification states:

"Undisturbed samples of Trisodium Phosphate Dodecahydrate (TSP) that have been exposed to the same environmental conditions as that in the mesh baskets shall be tested on a refueling frequency by:

(i) Verifying that a minimum total of 40 cubic feet of solid granular TSP is contained within the TSP storage baskets.

(ii) Verifying that when a representative sample of .6 ± .1 lbs. of TSP from a TSP storage basket is submerged, without agitation, in 89 ± 2 gallons of 77 ± 10°F borated water at refueling water concentration, the pH of the mixed solution is raised to ≥ 7 within 4 hours.

Failure to meet the above requirements will require replacement of the TSP."

EVENT DESCRIPTION

In October 1995, an investigation was initiated to determine if the current required amount of TSP in containment was adequate to provide a containment sump pH of greater than or equal to 7.0. This investigation included laboratory testing using standard chemistry techniques. The tests combined borated water and TSP at different concentrations and measured the pH of the resulting solution at one hour intervals. A number of tests were performed. Three were documented.

A test was performed using chemistry values that represented the worst case chemistry conditions allowed for by Technical Specifications. The test was performed using a TSP mass to liquid volume ratio of 0.5 lbs/91 gallons of borated water at 2150 ppm boric acid (the current minimum refueling boron concentration is 2000 ppm). The pH obtained after allowing the solution to sit for four hours was 6.91. During the performance of the other two tests a pH of 7.0 or greater was achieved, however, the initial conditions of these tests did not represent the worst case TSP mass to liquid volume ratio condition.

The results of this testing indicated that the Technical Specification required minimum TSP volume of 40 ft^3 would not be sufficient to achieve a sump pH of 7.0. Operating Safety Analysis Report (OSAR) 87-56, dated October 26, 1987, indicated that 2108 lbs of TSP (approximately 31 ft^3) was sufficient to achieve a sump pH above 7.0. On October 27, 1995, Condition Report (CR) 199500158 was written to address the discrepancy between the test results and the OSAR values.

The Nuclear Steam Supply System vendor, Combustion Engineering (ABB/CE), was contracted by the Omaha Public Power District (OPPD) to perform the calculations, independent of the OPPD investigation team, necessary to determine the amount of TSP required in containment to achieve a neutral post accident containment sump pH with the design values for boric acid concentrations. On December 4, 1995, a Plant Review Committee (PRC) meeting was held to discuss this issue and the related conclusions. The evaluation of the ABB/CE calculations, a review of the historic data related to the TSP issue, and chemistry tests performed as part of this investigation concluded that the Fort Calhoun Station had, at the beginning of the last several plant operating cycles, failed to maintain a sufficient quantity of TSP in the containment to produce a pH of 7.0 in the containment sump following a design basis LOCA. The combination of high boric acid concentrations in the RCS during the beginning of a cycle and the allowed boric acid concentrations in the SIRWT, Boric Acid Storage Tanks (BASTs), and Safety Injection Tanks (SITs) have resulted in conditions where Fort Calhoun Station was outside of its design basis. At 1540 Central Standard Time (CST) the PRC concluded that this condition constituted a condition outside of the design basis of the plant. At 1625 CST on December 4, 1995, a one hour non-emergency

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notification was made to the Nuclear Regulatory Commission (NRC) pursuant to 10CFR50.72(b)(1)(ii)(B). This report is being submitted pursuant to 10CFR50.73(a)(2)(ii).

An operability evaluation was completed which determined that the existing amount of TSP in the containment would neutralize the containment sump to a pH of 7.0 or greater for the current boric acid concentrations in the RCS, SIRWT, BASTs and the SITs. To ensure that boric acid concentrations during the rest of this operating cycle would remain consistent with those that the TSP operability determination was based on, administrative controls were placed on the boric acid concentration of plant components.

SAFETY ASSESSMENT

The Fort Calhoun Station Technical Specification Amendment 44 set the post accident containment sump water pH design basis at a pH of 7.0. Amendment 44 also states that Oak Ridge National Laboratory has performed experiments on stress corrosion cracking of stainless steel in acidic solutions and has recommended that a minimum pH of 6.5 be maintained in the sump water to reduce the probability of failure from a corrosive environment. In a recent Safety Evaluation Report (SER), for review of an evaluation performed by Baltimore Gas & Electric Calvert Cliffs using the smallest amount as found TSP, the NRC stated that the "as found" amounts of TSP (which resulted in a pH of 6.5) did not result in a condition adverse to safety. The amount of TSP, currently stored in the containment, has been able to maintain a post accident containment sump pH of greater than 6.5 throughout the operating history of the Fort Calhoun Station. Therefore, the amount of TSP in the containment sump has never represented a significant safety concern with respect to stress corrosion cracking. In addition, maintenance of a post-accident sump pH for the "as-found" Fort Calhoun Station conditions, will result in a bounded condition for generation of hydrogen in containment.

The lowering of the pH below 7.0, but not below 6.5, has not effected the severe accident basis in regards to the effectiveness of the sprays to reduce the iodine source term and has not increased the hydrogen generation.

CONCLUSIONS

Analyses were performed on the events surrounding this condition. These analyses concluded that concerns regarding the amount of TSP required to achieve a sump pH of 7.0 have arisen on several occasions in the history of the Fort Calhoun Station. The following historical information is provided to aid in understanding the conclusions of these analyses.

In October of 1973, Combustion Engineering (CE) recommended that a sufficient amount of TSP be available in containment for boric acid neutralization during the recirculation phase of a design basis LOCA. This recommendation was based on testing performed at the Oak Ridge National Laboratory which showed that increasing the pH of a boric acid solution to 7.0 effectively suppresses SCC in stainless steels. In

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support of this recommendation testing was completed by OPPD and CE to establish the TSP requirements for the Fort Calhoun Station. These calculations determined that a TSP mass to liquid volume ratio of 1772.4 lbs/315,000 gallons (0.005627 lbs/gallon solution) of water borated to 1700 ppm would be sufficient to achieve a pH of 7.0. This testing, along with correspondence from the Atomic Energy Commission, resulted in the basis for a change to the Fort Calhoun Station Technical Specification which established the following testing requirements:

At least every refueling outage, undisturbed samples of TSP that have been exposed to the same environmental conditions as the TSP in the mesh baskets shall be tested by verifying that when a representative sample of at least 0.5 lbs, of TSP from a TSP basket is submerged, without agitation, in 89.9 gallons of 150 - 200°F borated water at refueling boron concentration, the pH of the mixed solution is raised to $\geq$ 6.0 within 4 hours.

In 1977, the NRC issued IE Bulletin 77-04 to address errors in calculations to determine TSP requirements. OPPD responded by generating a TSP calculation and documenting the results in OSAR 77-06. This calculation demonstrated that a TSP mass to liquid volume ratio of 3000 lbs/373,350 gallons (0.008035) was the minimum required to achieve a post accident sump pH of 7.0. OSAR 77-06 was used as the basis for Amendment 44 to the Technical Specification which established the current TSP testing requirements. This submittal included Technical Specification test data from the period 1974 through 1977 which indicated that in two of the eight tests, a pH of 7.0 had not been achieved. The prevailing industry Technical Specification, however, required a pH of only 6.0 at this time.

In 1987, NRC inspection report (IER) 87-10 documented three unresolved items related to the TSP issue. The main concern was that a discrepancy existed between the Technical Specification requirement and the value stated in the USAR. The USAR stated that 3000 lbs of TSP were required, while the Technical Specification minimum requirement was 40 ft^3. Using a density of 53 lbs/ft^3 (from OSAR 77-06), 40 ft^3 results in 2120 lbs. In response to this discrepancy, OSAR 87-56 was generated to determine the amount of TSP required to raise containment sump pH to 7.0 and to compare this with the calculated amount in containment. This analysis established a TSP mass to liquid volume ratio of 2108 lbs/413,364 gallons (0.005100) at a boron concentration of 3017 ppm to reach a pH of 7.0. It was determined that 4206 lbs of TSP were available in containment with a density of 68.5 lbs/ft^3.

In the surveillance testing following this period, a pH of 7.0 or greater was achieved when using refueling boron concentrations along with the testing requirements, with the exception, of the 1990 tests which failed twice reaching pH values of 6.85 and 6.82. The TSP to liquid volume ratios for the tests were 0.61 lbs/90 gallons (0.006778) and 0.58 lbs/90 gallons (0.006444) respectively. Incident Report 90144 was written to document the surveillance test failure. In a follow-up memo to the Plant Chemistry Supervisor, it was stated that laboratory testing indicated that 42.6 ft^3 of TSP would be required to produce a neutral solution. The memo indicated that although the Technical Specification requirements of 40 ft^3 had been met, however, there was sufficient TSP in containment (greater than 42.6 ft^3) to produce a neutral solution. As directed by the Technical Specifications, all TSP in containment was replaced.

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In April of 1990, an analysis was completed using an Electric Power Research Institute (EPRI) computer code to determine the pH of the containment sump following a LOCA. Initial runs of the code indicated that Fort Calhoun Station might require additional TSP in containment. In a memo to one of the chemistry supervisors it was suggested that the Technical Specification pH be changed to a value that could be shown to protect the plant, rather than a value of 7.0. Other recommendations were made including installing drip protectors to protect the TSP from leaks and condensation, or determining a useful life for the TSP and the replacement frequency of TSP. There was no documentation found that these recommendations were further reviewed or implemented.

Also during April of 1990, a memorandum was issued to the Plant Manager and Manager Station Engineering from Quality Assurance which references the same EPRI computer code and that an amount of TSP below 45 ft^3 may be inadequate to achieve a pH of greater than 7.0. The QA department requested that this discrepancy be addressed. There is no documentation indicating that this concern was ever addressed.

During the preparation of the Design Basis Documents (DBD) for OPPD, the questions on the adequacy of TSP in containment were documented in DBD number 131 "Containment Spray", open item number 36. The DBD's were completed during the 1989 to 1991 time frame. This open item resulted from a letter from ABB which stated that an ABB calculation had determined that as much as 7500 lbs of TSP would be required to achieve a pH of 7.0. It was also noted that this issue had been discussed between ABB and OPPD personnel as recently as 1989, but, discussions and resolutions were never formally documented. This letter also stated that the discrepancy between the mentioned calculation and OSAR 87-56 was primarily a difference in assumptions used. ABB stated that, given the stated assumptions, the OSAR 87-56 calculation was correct. The DBD open item was closed out in 1992 based on this letter.

Incident Report number 930276 was written in 1993 and identified a problem with obtaining the latest refueling boron concentration from the Core Operating Limits Report (COLR) for the TSP surveillance test. The cycle 16 COLR listed a refueling boron concentration of 1700 ppm when the cycle 15 refueling boron concentration was changed to 1900 ppm. This change in refueling boron concentration would affect the TSP test results. As a result of this question, commitment 940066/01 was written to recalculate the TSP requirement using multiple disassociation constants for TSP and boric acid. The incident report and commitment were closed with a memorandum to the Plant Chemistry Supervisor which demonstrated that the 40 ft^3 of TSP will not achieve a pH of 7.0 when using the EPRI code and applying the disassociation constants at 150°C. The pH was calculated at 6.96 and was stated as not being a concern since the temperature increase used in the calculation decreases the pH of the neutral solution from that at 25°C.

The analyses identified the following causes for the inadequate amount of TSP in the containment sump:

1) Key nuclear organization personnel should have been more proactive and addressed the TSP issue more thoroughly when the concern was first identified in 1987.

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2) As part of the changes to the Technical Specification and USAR resulting from the OSAR calculations, the testing ratio of TSP to liquid volume in the Technical Specification should have been revised to ensure that the worst case was analyzed.

3) In support of the OSAR calculations related to TSP requirements performed in 1977 and 1987, additional laboratory testing should have been completed to provide updated baseline data to confirm that the testing required by the Technical Specification would verify that the calculated TSP to liquid volume ratios were correct at varied boron concentrations.

CORRECTIVE ACTIONS

The following corrective actions have been implemented:

1) Appropriate calculations and analyses have been performed using current industry techniques to verify that the amount of TSP required in the containment sumps is available to ensure that a neutral pH for cycle 16 (the current operating cycle) can be achieved following a LOCA.

2) An operability evaluation was completed on December 4, 1995. The evaluation determined that the plant met its design basis with the existing amount of TSP in containment and the boron concentrations in the SIRWT, BASTs, RCS and SITs that existed at the time of the evaluation. Administrative controls, in the form of an Operations Memorandum, were put in place to keep from invalidating the assumptions of the evaluation. Additional calculations were subsequently completed that determined that continued plant operation would be allowable with the normal plant limits on boron concentration for the BASTs and SITs, if the concentration of boron in the SIRWT were limited to 2300 ppm, and the RCS boron concentration were limited to 1175 ppm. Revised administrative guidance was provided to the operators by Operations Memorandum on December 29, 1995.

3) In OPPD's continuing effort to foster improved communication among Fort Calhoun Station personnel, a new Condition Reporting (CR) system was implemented in September of 1995 This system was designed to assure that the responses to CR's would be timely and effective. Experience to date has shown that the questioning attitude of plant personnel is improving, as evidenced by the number of CR's written to date. The daily Corrective Action Group meetings, which are chaired by the Plant Manager, are attended by senior members of the nuclear organization. The review of these problems by senior nuclear managers facilitates open communication between the plant operating staff and support groups.

These additional corrective actions will be implemented.

1) A modification will be accomplished to put additional TSP into the containment sump prior to entering mode two (2) for cycle 17 operation (the next refueling outage is currently scheduled to begin in September 1996).

2) The Updated Safety Analysis Report (USAR), Technical Specifications and appropriate design basis documents will be updated with the results of the calculations and analyses. The USAR will be corrected during the next regularly scheduled update, following the next refueling outage. An application for amendment to the Technical Specifications will be submitted by May 31, 1996. The DBDs will be revised following the completion of the modification.

3) Based on the above revisions chemistry procedure CH-ST-CH-0002 "Phosphate Basket Inspection" will be revised to ensure that Technical Specification requirements for the TSP are properly verified. This will be completed as part of the normal Technical Specification amendment process.

4) Training on the document changes and modification, scheduled for the fall of 1996, will be provided to the appropriate groups at the Fort Calhoun Station no later than March 1, 1997.

5) To ensure that the quantity of TSP in the containment continues to be adequate to meet the design criteria for future operating cycles, the calculations and analyses used to determine the quantity of TSP in the containment will be reviewed as part of each operating cycle's core reload analysis.

PREVIOUS SIMILAR EVENTS

No previous LERs have been submitted concerning the inability of the TSP in containment to maintain post LOCA containment sump pH at 7.0 or greater.