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POWER SYSTEMS

STN 50-470F

April 25, 1985
LD-85-019

Hugh L. Thompson, Director
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: CESSAR Chemistry Limits

References: (A) C-E Letter LD-84-070, A. E. Scherer to D. G. Eisenhut, dated December 5, 1984

(B) NRC Letter, C. O. Thomas to A. E. Scherer, dated March 25, 1985

(C) SECY-84-13A, dated September 7, 1984

(D) ANPP-31561, E. E. Van Brunt, Jr., to G. W. Knighton, dated December 21, 1984

(E) ANPP-31831, E. E. Van Brunt, Jr., to G. W. Knighton, dated January 31, 1985

Dear Mr. Thompson:

Reference (A) forwarded, for your review and approval, revised water chemistry limits to be used by applicants referencing CESSAR. These changes were made to be consistent with Combustion Engineering's (C-E's) current guidance to operating plants. Reference (B) and discussions with the NRC Chemical Engineering Branch have identified a concern that these revised limits may not be consistent with NRC guidance in the forthcoming Generic Letter on Steam Generator Tube Integrity [a draft is contained in Reference (C)].

To resolve this concern, the CESSAR chemistry limits of Reference (A) have been compared with the applicable portions of the NRC draft guidance in Reference (C). The portions of Reference (C) which are applicable to chemistry control are Sections 3.a (Secondary Water Chemistry Program) and 3.b (Condenser Inservice Inspection Program).

In Section 3.a, the NRC indicates that the EPRI Steam Generator Owners Group (SGOG), "PWR Secondary Water Chemistry Guidelines, October 1982", will be used as a basis for NRC review of chemistry programs. C-E has, therefore, performed a comparison between the CESSAR proposed chemistry limits and the EPRI SGOG water chemistry guidelines from October 1982. Attachment (1) provides this comparison. In a meeting on April 3, 1985 with the Chief of the NRC Chemical

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Engineering Branch, the NRC indicated that this information was acceptable technically. In summary, the CESSAR chemistry limits are consistent with and, in some cases, more limiting than the EPRI SGOG secondary water chemistry guidance of October 1982.

In Section 3.b [Attachment (2)], the NRC indicates that a condenser inservice inspection program should be implemented. The recommendations in this section are beyond the scope of the CESSAR design.

The NRC has also raised questions concerning primary chemistry aspects of the Reference (A) chemistry program. Attachment (3) responds to those questions. Question 1 and its response were previously provided on the Palo Verde docket by Reference (D). Questions 2 through 6 and the associated responses were previously provided on the Palo Verde docket by Reference (E). Question 7 was raised by the NRC in the aforementioned meeting on April 3, 1985.

C-E understands from conversations during the April 3, 1985 meeting that the information provided in Attachments (1) and (3) will complete the action requested in Reference (B) and close this issue. Should you have any questions or comments concerning this subject, please feel free to call me or Mr. T. J. Collier of my staff at (203) 285-5215.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:las
Attach.
cc: P. Moriette (NRC)

ATTACHMENT 1

COMPARISON

OF

NRC SECONDARY WATER CHEMISTRY GUIDANCE
(SECY-84-13A)

WITH

PVNGS/CESSAR PROPOSED WATER CHEMISTRY

3.a SECONDARY WATER CHEMISTRY PROGRAM

Staff Recommended Action

Licensees and applicants should have a secondary water chemistry program (SWCP) to minimize steam generator tube degradation.

The specific plant program should incorporate the secondary water chemistry guidelines in Standard Review Plan (SRP) Section 5.4.2.1, Revision 3, and should address measures taken to minimize steam generator corrosion, including materials selection, chemistry limits, and control methods. In addition, the specific plant procedures should include progressively more stringent corrective actions for out-of-specification water chemistry conditions. These corrective actions should include power reductions and shutdowns, as appropriate, when excessively corrosive conditions exist. Specific functional individuals should be identified as having the responsibility/authority to interpret plant water chemistry information and initiate appropriate plant actions to adjust chemistry, as necessary.

Revision 3 to Standard Review Plan (SRP) Section 5.4.2.1 incorporates the SGOG Special Report EPRI-NP-2704 "PWR Secondary Water Chemistry Guidelines," October 1982 as a review basis. These guidelines were prepared by the Steam Generator Owners Group Water Chemistry Guidelines Committee and represent and consensus opinion of a significant portion of the industry for state-of-the-art secondary water chemistry control. It is anticipated that Revision 4 to Standard Review Plan (SRP) Section 5.4.2.1 will incorporate a revision to EPRI-NP-2704 as the review basis.

Reference

Section 2.5 of NUREG-0844.

PVNGS/CESSAR PROPOSED WATER CHEMISTRY BASED ON
CURRENT C-E CHEMISTRY RECOMMENDATIONS

EPRI-SGOG GUIDELINES, REVISION 0 INCORPORATED
INTO C-E CHEMISTRY RECOMMENDATIONS

PVNGS/CESSAR PROPOSED WATER CHEMISTRY IS MORE
CONSERVATIVE THAN EPRI-SGOG GUIDELINES, REVISION 0

2.4.2 Tables of Parameters and Values

Table 2-3a (1)

RECIRCULATING STEAM GENERATOR
POWER OPERATION
FEEDWATER SAMPLE

Parameter	Frequency	Normal Value	Action Level 1	2	3
pH (ferrous system)	continuous	9.3-9.6	<9.3 >9.6		
pH (ferrous/copper system)	continuous	8.8-9.2	<8.8 >9.2*		
Cation Conductivity, μmho/cm	continuous	<0.2	>0.2		
Sodium, ppb	continuous	<3	>3		
Dissolved O_2, ppb	continuous	<3	>3		
Total Iron, ppb	weekly (integrated)	<20	>20		
Total Copper, ppb	weekly (integrated)	<2	>2		
Hydrazine, ppb	daily	>3 x $[O_2]$**	<3 x $[O_2]$**		
pH Control Additive	daily	10-50***	≤10, >50***		

* Action required only if experience shows increased copper transport at pH > 9.2
** Based on oxygen value measured in the condensate sample (Deleted)
*** To be consistent with pH

DENOTES PVNGS/CESSAR DIFFERENCE

(1) Table from EPRI-SGOG Guidelines Revision 0

Table 2-3b (1)

RECIRCULATING STEAM GENERATOR
POWER OPERATION
BLOWDOWN SAMPLE

Parameter	Frequency	Normal Value	Action Level 1	2	3
pH (ferrous system)	continuous	>9.0 9.0-9.6	<9.0, >9.6		
pH (ferrous/copper system)	continuous	8.5-9.2	<8.5 >9.2*		
Cation Conductivity, μmho/cm	continuous	<0.8	>0.8	>2	>7
Sodium, ppb	continuous	<20	>20	>100	>500
Chloride, ppb	daily	<20	>20	>100	
Silica, ppb	daily	<300	>300		
Sulfate, ppb		<15	>15	>100	

*Action required only if experience shows increased copper transport at pH > 9.2

Table 2-3c (1)

RECIRCULATING STEAM GENERATOR
POWER OPERATION
CONDENSATE SAMPLE

Parameter	Frequency	Normal Value	Action Level 1	2	3
Dissolved O_2, ppb (ferrous system)	continuous	<10	>10	>30 >50	
(ferrous/copper system)	continuous	<10	>10	>30	
pH (ferrous system)		9.3-9.6	<9.3, >9.6		
(ferrous/copper) system		8.8-9.2	<8.8, >9.2		
Sodium, ppb		<3			

| DENOTES PVNGS/CESSAR DIFFERENCE

(1) Table from EPRI-SGOG Guidelines Revision 0

FEEDWATER

DIFFERENCES

	EPRI REV. 0	PVNGS/CESSAR
- HYDRAZINE, PPB	> 3 x (O_2)**	10-50

** BASED ON OXYGEN VALUE MEASURED IN THE CONDENSATE SAMPLE

JUSTIFICATION

- PVNGS/CESSAR PROPOSED CHEMISTRY LIMITS ARE CONSISTENT WITH THE INTENT OF THE EPRI-SGOG REVISION 0 GUIDELINES.

- THE LOWER LIMIT ON HYDRAZINE IS ESTABLISHED TO ENSURE A SUFFICIENT RESIDUAL TO REMOVE ANY OXYGEN. THE UPPER LIMIT ON HYDRAZINE IS ESTABLISHED TO CONTROL AMMONIA FORMATION.

STEAM GENERATOR

DIFFERENCES

	EPRI REV. 0	PVNGS/CESSAR
- pH (FERROUS SYS)	>9.0	9.0-9.6
- SULFATE, PPB	--	<15

JUSTIFICATION

- PVNGS/CESSAR PROPOSED CHEMISTRY LIMITS ARE CONSISTENT WITH AND MORE LIMITING THAN THE EPRI-SGOG REVISION 0 GUIDELINES.

- AN UPPER LIMIT ON pH OF 9.6 HAS BEEN ADDED TO PROTECT AGAINST AN INADVERTENT ADDITION OF CAUSTIC, AND TO LIMIT NH_3 CONCENTRATION IN THE CONDENSATE SYSTEM (WHICH COULD INCLUDE A COPPER ALLOY TUBESHEET EVEN THOUGH CLASSIFIED "ALL FERROUS").

- THE PARAMETER SULFATE IS MONITORED TO PRECLUDE SULFATE INDUCED INCONEL 600 CORROSION.

CONDENSATE

DIFFERENCES

	EPRI REV. 0	CESSAR/PVNGS
- DISSOLVED O_2, PPB	(ACTION 2) >50	>30
- pH		
(FERROUS SYS)	--	9.3-9.6
(FERROUS/COPPER SYS)	--	8.8-9.2
- SODIUM, PPB	--	<3

JUSTIFICATION

- PVNGS/CESSAR PROPOSED CHEMISTRY LIMITS ARE CONSISTENT WITH AND MORE LIMITING THAN THE EPRI-SGOG REVISION 0 GUIDELINES.
- PVNGS/CESSAR PROPOSED CHEMISTRY CHANGES HAVE ONE O_2 LIMIT FOR BOTH FERROUS AND FERROUS/COPPER SYSTEMS. THE MORE CONSERVATIVE ACTION 2 EPRI-SGOG LIMIT IS APPLIED FOR BOTH TYPES OF SYSTEMS.
- THE PARAMETER pH HAS BEEN ADDED FOR CORROSION CONTROL IN THE CONDENSATE SYSTEM.
- THE PARAMETER SODIUM HAS BEEN ADDED FOR INDEPENDENT VERIFICATION OF CONDENSER LEAKAGE, UPSTREAM OF FEEDWATER INDICATION WHICH IS DILUTED BY HP DRAINS.

EPRI-SGOG REV. 0 ACTION LEVELS

ACTION LEVEL 1: IMPLEMENTED WHENEVER AN OUT-OF-NORMAL VALUE IS DETECTED.

ACTIONS:

A) RETURN PARAMETER TO WITHIN NORMAL VALUE RANGE WITHIN ONE WEEK FOLLOWING CONFIRMATION OF EXCURSION

B) IF PARAMETER IS NOT WITHIN NORMAL VALUE RANGE WITHIN ONE WEEK FOLLOWING CONFIRMATION OF EXCURSION GO TO ACTION LEVEL 2 FOR THOSE PARAMETERS HAVING ACTION LEVEL 2 VALUES

ACTION LEVEL 2: IMPLEMENTED WHEN CONDITIONS EXIST WHICH HAVE BEEN SHOWN TO RESULT IN SOME DEGREE OF STEAM GENERATOR CORROSION DURING EXTENDED FULL (100%) POWER OPERATION

ACTIONS:

A) REDUCE POWER TO APPROPRIATE LEVEL (TYPICALLY 30% OR LESS) WITHIN FOUR HOURS OF INITIATION OF ACTION LEVEL 2

B) RETURN PARAMETER TO WITHIN NORMAL VALUE RANGE WITHIN 100 HOURS OR GO TO ACTION LEVEL 3 FOR THOSE PARAMETERS HAVING ACTION LEVEL 3 VALUES

ACTION LEVEL 3: IMPLEMENTED WHEN CONDITIONS EXIST WHICH WILL RESULT IN RAPID STEAM GENERATOR CORROSION AND CONTINUED OPERATION IS NOT ADVISABLE

ACTIONS

A) SHUT DOWN WITHIN FOUR HOURS AND CLEAN UP BY FEED AND BLEED OR DRAIN AND REFILL AS APPROPRIATE UNTIL NORMAL VALUES ARE REACHED

PVNGS/CESSAR

WHEN THE NORMAL RANGE IS EXCEEDED, IMMEDIATE INVESTIGATION OF THE PROBLEM SHOULD BE INITIATED, SAMPLING FREQUENCY INCREASED TO THE ABNORMAL LEVEL (AT LEAST TWICE PER 8 HOUR SHIFT) AND BLOWDOWN INCREASED TO ONE (1) PERCENT OF THE MAIN STEAMING RATE. THE PROBLEM SHOULD BE CORRECTED AND THE PARAMETER(S) RETURNED TO THE NORMAL RANGE WITHIN ONE WEEK. IF THIS CANNOT BE DONE, AND THE PARAMETER HAS A LISTED ABNORMAL RANGE, POWER SHOULD BE REDUCED TO 25% AS IF THE ABNORMAL RANGE HAD BEEN EXCEEDED.

WHEN THE ABNORMAL RANGE IS EXCEEDED, POWER SHOULD BE REDUCED TO THE LOWEST VALUE (MAXIMUM OF 25%) CONSISTENT WITH AUTOMATIC OPERATION OF THE FEED SYSTEM. CONTINUED PLANT OPERATION IS THEN POSSIBLE WHILE CORRECTIVE ACTION IS TAKEN. POWER REDUCTION SHOULD BE INITIATED WITHIN FOUR HOURS OF EXCEEDING THE ABNORMAL RANGE. THE PROBLEM SHOULD BE CORRECTED AND THE PARAMETER(S) RETURNED TO THE NORMAL RANGE WITHIN ONE HUNDRED (100) HOURS. IF THIS CANNOT BE DONE, THE UNIT SHOULD BE SHUTDOWN. DRAINING OR FLUSHING OF THE STEAM GENERATORS WILL BE NECESSARY TO REDUCE THE IMPURITY CONCENTRATION.

IMMEDIATE SHUTDOWN LIMITS ARE PROVIDED IN THE NOTES ON THE STEAM GENERATOR CHEMISTRY FOR THE PARAMETERS IDENTIFIED BELOW.

CATION CONDUCTIVITY	>7.0 μMHO/CM
SODIUM	>500 PPB

(THESE PARAMETERS ARE THE ONLY ONES FOR WHICH EPRI SGOG REVISION 0 GUIDELINES HAVE LEVEL 3 ACTION REQUIRED.)

ACTION COMPARISON

- EPRI-SGOG REVISION 0 GUIDELINES ACTION LEVEL 1 IS IDENTICAL TO ACTION REQUIRED BY PVNGS/CESSAR FOR ANY PARAMETER OUTSIDE NORMAL LIMITS

- ALL PARAMETERS WHICH HAVE ACTION LEVEL 2 OR 3 IN EPRI-SGOG REVISION 0 GUIDELINES HAVE IDENTICAL ACTION SPECIFIED BY PVNGS/CESSAR

CONCLUSION

THE PVNGS/CESSAR PROPOSED SECONDARY CHEMISTRY LIMITS ARE CONSISTENT WITH, AND IN SOME CASES MORE LIMITING THAN, THE EPRI STEAM GENERATOR OWNERS GROUP PWR SECONDARY WATER CHEMISTRY GUIDELINES REVISION 0

3.b CONDENSER INSERVICE INSPECTION PROGRAM

Staff Recommended Action

Licensees should implement a condenser inservice inspection program. The program should be defined in plant specific safety-related procedures and include:

1. Procedures to implement a condenser inservice inspection program that will be initiated if condenser leakage is of such a magnitude that a power reduction corrective action is required more than once per three month period; and

2. Identification and location of leakage source(s), either water or air;

3. Methods of repair of leakage;

4. Methodology for determining the cause(s) of leakage;

5. A preventive maintenance program.

Reference

Section 2.6 of NUREG-0844.

ATTACHMENT (3)

RESPONSES TO ADDITIONAL NRC QUESTIONS

Question 1: (CESSAR Table 9.2-1) Why was the parameter "gaseous content" deleted?

Response 1: The original description did not distinguish between deaerated and non-deaerated as a required condition for makeup water. Removal of oxygen is controlled in the reactor coolant and steam generators by employing hydrogen limits (Table 9.3-1) and oxygen, plus hydrazine limits in the feed and condensate systems (Table 10.3.4-2), respectively.

Question 2: (CESSAR Table 9.2-1) Should Suspended Solid limits be retained at the demineralizer effluent to determine that demineralizer resin is functioning properly?

Response 2: Water quality measurements, including conductivity, taken of the demineralizer effluent will detect makeup system mal-operation which could result in resin release or suspended solids release.

The quality of the Reactor Coolant makeup water is controlled at the Reactor Makeup Water Tank (RMWT) to meet the limits specified in Table 9.3-1.

The quality of the secondary system water is controlled at the condensate, feedwater and steam generator to meet the limits specified in CESSAR Tables 10.3.4-2 and 10.3.4-1, respectively.

The suspended solid limits therefore need not be retained in CESSAR Table 9.2-1 for the demineralizer effluent.

Question 3: (CESSAR Table 9.3-1) Why was the abnormal limit column on Reactor Makeup Water deleted?

Response 3: The abnormal limits were deleted for the Reactor Makeup Water since the abnormal limits for the reactor coolant makeup water were less restrictive than the normal limits of Table 9.3-1. Prudent control of reactor coolant impurities, also in Table 9.3-1, is now based on the more restrictive normal limits alone.

Question 4: (CESSAR Table 9.3-1) Are there any sources of Reactor Makeup Water other than the demineralizer which could introduce SiO_2 or Conductivity to the Reactor Makeup Storage Tank?

Response 4: Yes, however, the limits of Table 9.2-1 are applicable to all external sources of water used to supply the Reactor Makeup Water Storage Tank (RMWT). Thus, SiO_2 and Conductivity are appropriately controlled in the RMWT.

Question 5: (CESSAR Table 9.3-1) Hydrazine does not mix well at low pressures and temperatures. Can 30-50ppm Hydrazine be maintained in the ractor coolant system at less than 150°F?

Response 5: With RCS recirculation provided by shutdown cooling system operation, there should be no difficulty in maintaining 30-50ppm Hydrazine at low temperatures. As an example, steam generator wet layup chemistry utilizes Hydrazine in concentrations of 75-200ppm, a specification which is routinely achieved.

Question 6: (CESSAR Table 9.3-1) Should note (10) to this table be extended to whenever reactor coolant system temperature is less than 150°F?

Response 6: Note (10) to Table 9.3-1 applies to operation below 150°F. Oxygen is controlled prior to exceeding 150°F during heatup by either maintaining oxygen concentration below 0.1ppm or by having a Hydrazine residual present at a concentration of 1.5 times the oxygen concentration.

Question 7: How are modes of Steam Generator operation defined for chemistry purposes?

Response 7: For chemistry purposes, modes of Steam Generator operation are defined as:

(1) Cold Shutdown/Wet Layup - This mode encompasses all the time when the RCS is < 210°F, Modes 5 and 6 as defined by the CESSAR Technical Specifications.

(2) Heatup (> 210°F, < 5% Power) - This mode covers the time when the RCS is > 210°F but < 5% power, Modes 2, 3 and 4 as defined by the CESSAR Technical Specifications.

(3) Power Operation - This mode applies to all periods when reactor power is > 5%, Mode 1 in the CESSAR Technical Specifications.

It should be noted that where chemistry requirements indicate that the reactor should be shut down, the intended mode of operation corresponds to CESSAR Technical Specification Mode 3, 4, 5 or 6.