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SALEM GENERATING STATION – UNIT 1 and UNIT 2
FACILITY OPERATING LICENSE NOS. DPR 70 and DPR-75
NRC DOCKET NOS. 50-272 and 50-311

Subject: **RESPONSE TO RAI #1 and RAI #2 ON LCR S06-10 (TAC Nos. MD4843 & 4844)**
STEAM GENERATOR FEEDWATER PUMP TRIP, FEEDWATER ISOLATION VALVE RESPONSE TIME TESTING and CONTAINMENT COOLING SYSTEM

References: (1) Letter from PSEG to NRC: "License Change Request for S06-10, Steam Generator Feedwater Pump Trip, Feedwater Isolation Valve Response Time Testing and Containment Cooling System, Salem Nuclear Generating Station, Units 1 and 2, Facility Operating Licenses DPR-70 and DPR-75, Docket Nos. 50-272 and 50-311", dated March 16, 2007

(2) Letter from NRC to PSEG: "Salem Nuclear Generating Station, Units 1 and 2, Request for Additional Information, Amendment Request Re: Steam Generator Feedwater Pump Trip, Feedwater Isolation Valve Closure Response Times, and Containment Fan Coil Unit Cooling Water Flow Rate (TAC Nos. MD4843 & 4844)", dated August 28, 2007

In Reference 1, PSEG Nuclear LLC (PSEG) submitted License Change Request (LCR) S06-10 to amend the Technical Specifications (TS) for the Salem Nuclear Generating Station, Units 1 and 2 (Reference 1). LCR S06-10 entails (1) new TS surveillance requirements for Steam Generator Feedwater Pump (SGFP) trip and Feedwater Isolation Valve (FIV) closure, and (2) revised TS surveillance requirements for Containment Fan Cooler Unit (CFCU) flow. The LCR relates to adoption of a new containment response analysis that credits Steam Generator Feedwater Pump (SGFP) Trip and Feedwater Isolation Valve closure (on a feedwater regulator valve failure) to reduce the mass/energy release to containment during a Main Steam Line Break (MSLB). The containment analysis also credits a reduced heat removal capability for the Containment Fan Cooler Units (CFCUs), allowing a reduction in the required Service Water (SW) flow to the CFCUs.

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The NRC provided PSEG three Request for Additional Information (RAI) on LCR S06-10 (the RAIs were formally provided via Reference 2). On July 30th, 2007, PSEG and the NRC discussed RAI#1 and RAI#2 via teleconference to provide additional clarification. The response to RAI#1 and RAI#2 (Questions EMCB-1, SBPB-1, SBPB-2, and SBPB-3) are provided as Attachments to this submittal. The response to RAI#3 will be provided at a later date.

In accordance with 10CFR50.91(b)(1), a copy of this letter has been sent to the State of New Jersey.

PSEG has evaluated the additional information provided in Attachment 1 in accordance with 10CFR50.91(a)(1), using the criteria in 10CFR50.92(c), and has determined there is no impact to the no significant hazards consideration provided in Reference 1. There is also no impact to the 10 CFR 51.22(c)(9) environmental assessment provided in Reference 1.

If you have any questions or require additional information, please do not hesitate to contact Mr. Jamie Mallon at (610) 765-5507.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 8/30/07
(Date)

Sincerely,

Robert C. Braun
Site Vice President
Salem Generating Station

Attachments 2

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REQUEST FOR ADDITIONAL INFORMATION #1
REGARDING PROPOSED LICENSE AMENDMENT
STEAM GENERATOR FEEDWATER PUMP TRIP,
FEEDWATER ISOLATION VALVE CLOSURE RESPONSE TIMES,
AND CONTAINMENT FAN COIL UNIT COOLING WATER FLOW RATE
SALEM NUCLEAR GENERATING STATION, UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311

By letter dated March 16, 2007, PSEG Nuclear LLC (PSEG or the licensee) submitted an amendment request for Salem Nuclear Generating Station (Salem), Unit Nos. 1 and 2. The proposed amendment would add new Technical Specification (TS) requirements for the response times associated with a steam generator feedwater pump (SGFP) trip and feedwater isolation valve (FIV) closure. The amendment would also revise the TS requirements for the containment fan cooler unit (CFCU) cooling water flow rate. These changes are associated with a revised containment response analysis that credits a SGFP trip and FIV closure (on a feedwater regulator valve failure) to reduce the mass/energy release to the containment during a main steam line break (MSLB). The containment analysis also credits a reduced heat removal capability for the CFCUs, allowing a reduction in the required service water (SW) flow to the CFCUs.

The NRC staff has reviewed the information the licensee provided that supports the proposed amendment and would like to discuss the following issues to clarify the submittal.

EMCB-1: PSEG's letter dated May 8, 1998, provided a response to an NRC staff request for additional information (RAI) regarding Generic Letter (GL) 96-06. The GL RAI response indicated that, for Salem Unit 2 penetrations M22A, M27, and M45, relief valves would be installed to protect these penetrations from thermally-induced pressurization. However, based on the discussion in Section 6.8 of Enclosure 2 to PSEG's application dated March 16, 2007, regarding the impact of the proposed amendment on these penetrations, it does not appear that relief valves were installed. Please clarify if these penetrations are protected by relief valves as indicated in the submittal dated May 8, 1998.

RESPONSE

PSEG letter dated May 8, 1998 stating that penetrations M22A, M27 and M45 would have relief valves installed is accurate, as discussed below.

Engineering Evaluation S-C-CBV-MEE-1982, Section 6.8 (Enclosure 2 of the LCR S06-10 submittal) states the following:

"Salem Unit 2 Penetrations M22A, M27 and M45 were evaluated in Reference 29 [S-2-ZZ-MEE-1177], *and are estimated to have a limiting pressure of 218 psig, 218 psig and 417 psig, respectively. The limiting pressures for these isolated piping runs located in containment are based on the design of the Containment Isolation Valve (CIV) air operator spring rates for 2WR80, 2WL13 and 2WL17. The CIV valves are pressurized under the plug seat and are spring shut. As the isolated water volume is heated from elevated containment temperatures, the pressure will*

increase until the upward force on the valve disk exceeds the spring closing force. The disk will move from the seat and provide a small leakage path to the downstream system piping. Leakage from isolated penetrations M22A, M27 and M45 will discharge to the Pressurizer Relief Tank, the CVCS Holdup Tank and the Waste Holding Tank, respectively. The increase in the containment temperature (WCAP-16503) does increase the calculated peak pressure in Reference 29 due to the design of the piping and the valves adjacent to penetrations M22A, M27 and M45."

The referenced engineering evaluation (S-2-ZZ-MEE-1177) demonstrated that these penetrations were acceptable without relief valve installation, but also stated (in Section 4.0) that installation of relief valves was under consideration. In fact, DCP 2EC-03612 was implemented and did install relief valves for these penetrations as indicated below.

Penetration M22A
Relief valve 2WR191

Penetration M27
Relief valves 2WL475 and 2WL476

Penetration M45
Relief valves 2WL477 and 2WL478

Section 6.8 of S-C-CBV-MEE-1982 will be revised to state that penetrations M22A, M27 and M45 have relief valves installed per DCP 2EC-03612.

REQUEST FOR ADDITIONAL INFORMATION #2
REGARDING PROPOSED LICENSE AMENDMENT
STEAM GENERATOR FEEDWATER PUMP TRIP,
FEEDWATER ISOLATION VALVE CLOSURE RESPONSE TIMES,
AND CONTAINMENT FAN COIL UNIT COOLING WATER FLOW RATE
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The NRC staff has reviewed the information the licensee provided that supports the proposed amendment and would like to discuss the following issues to clarify the submittal.

SBPB-1: The proposed change would reduce the minimum cooling water flow rate to each CFCU from 2550 gallons per minute (gpm) to 1300 gpm. The reduction in required SW flow rate to the CFCUs would reduce its heat removal capability in the containment. The minimum flow rate requirements in the accident analyses for loss-of-coolant accident (LOCA) and MSLB are based on clean-tube flow rate. Explain how the accident analysis was performed with consideration of tube fouling, and what safety margin was assumed in the analysis for tube fouling.

RESPONSE

The CFCU performance curve used in the WCAP-16503 containment analysis was developed with sufficient conservatism including the effects of fouling.

The total minimum required heat load at 271°F from Table 6.1-3 of WCAP-16503 is 31325 BTU/sec, which equates to 37.6 MBTU/hr per CFCU. Per PSEG Calculation S-C-CBV-MDC-1637, Revision 3, the minimum SW flow to the CFCU to obtain this heat load is 930 gpm, based on a SW temperature of 93°F and a thermal fouling of 0.0035 hr-°F-ft^2/BTU. The assumed thermal fouling resistance of 0.0035 hr-°F-ft^2/BTU is greater than the current CFCU design thermal fouling resistance of 0.0030 hr-°F-ft^2/BTU.

System design with the fixed resistance modifications has margin to accommodate degradation of CFCU thermal performance from thermal fouling, biofouling, or silt accumulation. This margin results from the following considerations:

- The assumed SW supply temperature of 93°F is conservative, as the current system design value is 90°F.
- The minimum required SW flow with the fixed resistance modifications is higher than necessary to meet the heat duty requirement in order to ensure no two-phase flow in the system (1250 gpm versus 930 gpm).

Based on a SW flow of 1250 gpm and a temperature of 90°F, the maximum thermal fouling to obtain the minimum required heat load is about 0.0055 hr-°F-ft^2/BTU, 83% greater than the current design value.

SBPB-2: In considering the effects of surface fouling of the water side of the CFCUs and the residual heat removal heat exchangers, explain how you treat water side surface fouling of the CFCU in the analysis.

RESPONSE

Salem continuously chlorinates the SW system. Salem has an administrative 7-day limit on having the chlorination system out of service, which is part of the Station's response to NRC Generic Letter (GL) 89-13. This is detailed in Chemistry procedure SC.CH-SO.CL-0830, Chlorination System Startup and Shutdown. If the system is out of service for more than 7 days a notification is required per the same procedure. The 7-day limit is to allow for maintenance on the system. Chlorination has proven to be highly effective in preventing biofouling, as confirmed by thermal performance testing of the Component Cooling Heat Exchangers.

The existing GL 89-13 commitments for Salem are not being modified by this change request. All of the previously committed actions will continue to be performed by the station.

An evaluation (VTD 901163, Sheet 3) was performed to assess the potential silting within the CFCU tubes before and after the fixed hydraulic resistance modification. This evaluation determined the maximum size particle that can be maintained in a symmetrical suspension for a given flow rate and the maximum particle size that will not deposit at the same flow rate. A flow velocity of 3 ft/sec is sufficient to keep particles up to 500 microns in diameter in a symmetric suspension and particles up to almost 1500 microns in an asymmetric suspension. The large majority of particles in the Delaware River samples at Salem are under 200 microns and few are greater than 400 microns. With the fixed hydraulic resistance modifications, the velocity for normal operation is greater than 3 ft/sec, which is sufficient to transport particles larger than what is typically seen in the river samples taken at Salem.

The increased SW flow during normal operations and the GL 89-13 committed actions will be sufficient ensure that the water side of the CFCUs remains free of surface fouling.

SBPB-3: Cooling water systems serving the containment air coolers may experience two-phase flow conditions during postulated LOCA and MSLB scenarios. However, the

heat removal assumptions for design-basis accident scenarios were based on single-phase flow conditions. In Generic Letter 96-06, the NRC requested licensees to evaluate cooling water systems that serve containment air coolers to assure that the systems are not vulnerable to water-hammer and two-phase flow conditions. The staff has previously approved the licensee's evaluations and corrective actions to resolve this issue in a letter dated June 2, 2003. Please provide additional evaluations on this issue based on new parameters in the proposed TS changes.

RESPONSE

LCR S06-10 proposes to reduce the minimum CFCU loop flow rate from 2550 gpm to 1300 gpm. As discussed in Section 7 of S-C-CBV-MEE-1982, the "*minimum CFCU flow of 1300 gpm (1250 gpm to the CFCU + 50 gpm for the motor cooler) is adequate to meet the CFCU heat removal assumptions in WCAP-16503 and prevent flashing in the SW system with maximum heat transfer conditions.*"

Calculation S-C-CBV-MDC-1637, Revision 3 establishes the minimum CFCU flow requirements. The calculation considers the need to satisfy both the required accident heat removal capability and requirement to prevent two-phase flow.

Minimum CFCU Flow to Meet Required Heat Duty

The minimum CFCU flow necessary to ensure that the CFCUs can satisfy the heat removal capability credited in WCAP-16503 is 930 gpm. This value is based on a Service Water (SW) supply temperature and a thermal fouling factor that are greater than the current design values. The SW supply temperature of 93°F provides 3°F margin relative to the maximum Ultimate Heat Sink temperature of 90°F. The assumed tubeside fouling factor of 0.0035 hr-°F-ft^2/BTU is greater than the value previously used to assess minimum heat transfer with maximum fouling (0.0030 hr-°F-ft^2/BTU). Therefore, the flow of 930 gpm is sufficient to satisfy the heat removal requirement of the CFCU with margin for degraded heat transfer.

Accounting for the minimum required flow to the motor cooler (25 gpm), the total CFCU loop flow necessary to meet the CFCU and associated motor cooler heat duty is 955 gpm.

Minimum CFCU Flow to Maintain Water Solid Conditions

The minimum flow necessary to maintain water solid conditions in the CFCU and associated return piping path is determined in Calculation S-C-CBV-MDC-1637, Revision 3. It uses a conservative saturation margin analysis to demonstrate that 1250 gpm CFCU flow (1300 gpm total, including a 50 gpm allowance for the motor cooler) is sufficient to ensure fluid conditions remain above saturation pressure during worst case accident conditions (system aligned to provide minimum static pressure coupled with maximum heat transfer conditions in the CFCUs (zero thermal fouling) and a SW supply temperature of 93°F). The evaluation assesses saturation margin at key points in the CFCU return flow path. System pressures are determined using the benchmark hydraulic model of the SW system. The CFCU outlet temperature is determined using a benchmarked thermal model of the CFCUs. The evaluations use the maximum containment temperature for a LOCA from

WCAP-16503. Table 7.3-3 of S-C-CBV-MEE-1982 summarizes the results of the saturation margin evaluation (excerpted below). It shows positive saturation at each of the key locations evaluated.

Minimum CFCU Service Water Return Subcooling Margin
(Table 7.3-3 of S-C-CBV-MEE-1982)

Location	Node	Pressure (psia)	Temperature (°F)	Saturation Pressure (psia)	Margin (psia)
21 CFCU Outlet	93C	27.8	204.9	12.7	15.1
21 SW-223 Outlet	103	14.3	202.4*	12.1	2.2
21 CFCU Return Header	104A	12.2	202.4	12.1	0.1
24" SW Return Header	86	11.5	181.4**	7.8	3.7

Notes:
* Includes the effect of CFCU Coil and CFCU Motor Cooler outlet flow mixing.
** Includes the effect of multiple Service Water component outlet flow mixing.

The approach used in the saturation margin evaluation includes significant conservatism due to the difference in CFCU heat removal rates used in the containment evaluation and that used in the CFCU outlet temperature. The maximum containment temperature for a LOCA from WCAP-16503 is used to determine the CFCU outlet temperature. The containment temperature profile from WCAP-16503 credits an individual CFCU heat removal rate of 37.6 MBTU/hr; whereas the heat removal rate calculated with zero fouling and a CFCU flow of 1250 gpm is estimated at 70.0 MBTU/hr. Such a large increase in heat removal would be expected to reduce containment parameters resulting in a corresponding reduction in SW outlet temperature.

Design of the fixed resistance modifications provides significant flow margin relative to the new Technical Specification minimum required flow of 1300 gpm.

The discussion above focuses on the steady state response to a LOCA or MSLB, with or without a concurrent Loss-of-Offsite Power (LOOP) event. Generic Letter 96-06 required evaluation of the CFCUs for potential waterhammer transient events following LOOP and LOOP/LOCA events. The primary concern for CFCUs cooled by an open SW system is column separation when the SW pumps trip and column impact waterhammer following restart of the SW pumps. As discussed Section 6.8 of S-C-CBV-MEE-1982, Salem's response to GL96-06 was to install two 15,000 gallon accumulators on the SW system piping headers. The function of the SW accumulators is to inject water into each Service Water header during a LOOP to ensure that the Service Water piping, particularly downstream of the CFCUs, are maintained in a single phase condition until the Service Water Pumps are restarted from an Emergency Diesel Generator. This SW System design feature ensures that waterhammer cannot occur as two-phase conditions are not allowed to develop. The

SW Accumulator pressure and water level, which are based on the current modulating flow controls for the system, are conservative for the fixed resistance modifications due to the increase in system resistance. Therefore, the accumulator tanks will prevent two-phase flow conditions and potential waterhammer transients following a LOOP or LOOP/LOCA.

In summary, the 1300 gpm minimum flow for the CFCU is more than adequate to meet the CFCU heat removal assumptions in WCAP-16503 and is sufficient to ensure no two-phase flow for accident conditions. The existing SW accumulator tanks prevent two-phase flow conditions and potential waterhammer transients following a LOOP or LOOP/LOCA.