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Nuclear LLC

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United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001
Gentlemen:

SALEM GENERATING STATION –UNIT 2
FACILITY OPERATING LICENSE NO. DPR-75
NRC DOCKET NO. 50-311

Subject: **RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ON LICENSE AMENDMENT REQUEST S07-06, ONE-TIME CHANGE TO TECHNICAL SPECIFICATIONS, REFUELING OPERATIONS – DECAY TIME (TAC No. 7027)**

References: (1) Letter from PSEG to NRC: "Request for One-Time Change to Technical Specifications, Refueling Operations –Decay Time, License Amendment Request (LAR) S07-06, Salem Nuclear Generating Station, Unit 2, Facility Operating License DPR-75, Docket No. 50-311", dated October 17, 2007

In Reference 1, PSEG Nuclear LLC (PSEG) submitted License Amendment Request (LAR) S07-06, proposing a one-time revision to the requirements for fuel decay time prior to commencing movement of irradiated fuel. TS 3/4.9.3 "Decay Time" would be revised to allow fuel movement in the containment to commence at 86 hours after the reactor is subcritical for refueling outage 2R16. 2R16 is scheduled to commence on March 11, 2008[1]. Currently, TS 3/4.9.3 requires a fuel decay time of 100 hours prior to fuel movement between October 15th and May 15th.

The NRC provided PSEG a Request for Additional Information (RAI) on LAR S07-06. On January 3rd, 2008, PSEG and the NRC discussed the RAI to provide additional clarification. The response to the RAI is provided as an attachment to this submittal.

1 The March 11, 2008 scheduled start of 2R16 is a revision from the March 4, 2008 date provided in Reference 1. PSEG requests approval of the proposed License Amendment by March 8, 2008 to support the March 11 outage start date.

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NRR

If you have any questions or require additional information, please do not hesitate to contact Mr. Jeff Keenan at (856) 339-5429.

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

Executed on 1/11/08
(Date)

Sincerely,

Robert C. Braun
Site Vice President
Salem Generating Station

Attachments: 1

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REQUEST FOR ADDITIONAL INFORMATION

REGARDING PROPOSED LICENSE AMENDMENT

REFUELING OPERATIONS - DECAY TIME

SALEM NUCLEAR GENERATING STATION, UNIT NO. 2

DOCKET NO. 50-311

By application dated October 17, 2007, PSEG Nuclear LLC (the licensee) submitted an amendment request for Salem Nuclear Generating Station (Salem), Unit No. 2. The proposed amendment would allow a one-time revision to the requirements for fuel decay time prior to commencing movement of irradiated fuel in the reactor pressure vessel (RPV). Currently, Technical Specification (TS) 3/4.9.3, Decay Time" requires that: (a) the reactor has been subcritical for at least 100 hours prior to movement of irradiated fuel in the RPV between October 15th through May 15th; and (b) the reactor has been subcritical for at least 168 hours prior to movement of irradiated fuel in the RPV between May 16th and October 14th. The calendar approach is based on average river water temperature which is cooler in the fall through spring months. The proposed amendment would revise TS 3/4.9.3 to allow fuel movement to commence at 86 hours after the reactor is subcritical. The proposed change would only be applicable to Salem Unit 2 refueling outage 2R16 which is scheduled to commence on March 4, 2008.

The Nuclear Regulatory Commission 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.

1) Section 4.3.d of Attachment 1 to the application dated October 17, 2007, addresses the sensitivity of spent fuel pool temperature to ambient temperature in the fuel building. The comparison of spent fuel pool temperatures at various ambient air temperatures between 105 °F and 120 °F indicate the pool temperature is relatively insensitive to ambient air temperature following a loss of forced cooling. Explain how the Crosstie code models heat loss from the spent fuel pool to the ambient air volume within the building. Also, address why the insensitivity to ambient air temperature is both consistent with the model and a realistic representation of the expected temperature response of the pool to an actual loss of cooling event.

Response

The total heat loss from the Spent Fuel Pool (SFP) to the ambient air calculated by the CROSSTIE program consists of three parts – evaporative heat loss (Q_{evap}), convective heat loss (Q_{conv}) and radiation heat loss (Q_{rad}), as discussed in HOLTEC's Verification and Validation (V/V) document referenced in Section

4.3.a of LAR S07-06[2]. The evaporative heat is calculated based on mass transfer principles as follows:

$$Q_{evap} = m * A_s * h_{fg},$$

where m is the mass evaporation rate ($lb_m/hr\text{-}ft^2$), A_s is the pool surface area (ft^2), and h_{fg} is the latent heat of vaporization (BTU/lb_m). The mass evaporation rate is calculated as follows:

$$m = h_D(\Delta T) * (W_{ps} - W_s)$$

where W_{ps} is the humidity ratio of moist air at the pool surface temperature ($lb_{m\text{-}vapor}/lb_{m\text{-}dry\ air}$), W_s is the humidity ratio of moist air at the ambient air temperature, and $h_D(\Delta T)$ is the mass transfer coefficient at the pool surface as a function of the temperature difference between the pool and ambient air. The convective heat loss is calculated as follows:

$$Q_{conv} = h_c * A_s * \Delta T$$

where h_c is the convective heat transfer coefficient at the pool surface ($BTU/hr\text{-}ft^2\text{-}°F$). The radiation heat loss is calculated as follows:

$$Q_{rad} = \varepsilon * \sigma * A_s * (T^4_{pool} - T^4_{air})$$

where ε is the emissivity of water (0.94) and σ is the Stefan-Boltzmann constant ($0.1713*10^{-8}$ $BTU/hr\text{-}ft^2\text{-}°F$).

The insensitivity of SFP temperature to ambient air temperature is consistent with the CROSSTIE model, and is a realistic representation of the expected temperature response of the pool to an actual loss of cooling event, as discussed below.

The evaporative heat loss is the dominant component in the total heat loss to the ambient air. Any differences in convective or radiation heat loss between an ambient air temperature of 105°F and 120°F is insignificant. The dominant parameter in calculating Q_{evap} is the difference in vapor pressure between the pool surface and the ambient air (ΔP_v). (This is equivalent to the difference in humidity ratio provided in Holtec's V/V documentation as humidity ratio is a function of vapor pressure). A sensitivity study on the effect of ambient temperature on the peak SFP temperature for both normal cooling and loss of forced cooling is provided in Appendix B of Calculation S-C-SF-MDC-1800, Revision 6 (Attachment 4 of LAR S07-06). For the loss of forced cooling scenario, the peak SFP temperature is about 205°F. The vapor pressure at an

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[2] The Holtec V/V document was previously docketed by PSEG letter LR-N02-0331, dated October 2, 2002. See Page 2-4 of Appendix 2 of Attachment 2 of the letter for heat loss to ambient air methodology.

ambient air temperature of 105°F (1.10 psia) or 120°F (1.69 psia) is small compared to the vapor pressure at 205°F (12.78 psia). The difference in the ambient air vapor pressure between 105°F and 120°F is also small such that difference between ΔP_v for 105°F versus 205°F and ΔP_v for 120°F versus 205°F is small (5.1%). Furthermore, the change in vapor pressure with respect to temperature at 205°F is significantly greater than that at 105°F and 120°F. Therefore, an ambient air temperature of 120°F versus 105°F has relatively minor impact on the peak SFP temperature for a loss of forced cooling.

2) Assumption 3.3 in Attachment 4 to the application dated October 17, 2007, states that the fuel handling ventilation system must be operating to maintain the ambient air design temperature with the spent fuel pool temperature above 150 °F. Describe the basis for this assumption and the basis to conclude that the ventilation system would remain functional in the ambient air environment at spent fuel pool temperatures up to 180 °F.

Response

The requirement for the Fuel Handling Ventilation (FHV) System to be operating to maintain the ambient design air temperature is based on Calculation S-2-FHV-MDC-0706, "FHV System Heating/Cooling Load & Air Flow Determination Calculation - Unit 2". The original calculation was performed prior to the rerack of the SFPs (1992-1993), when the peak SFP temperature during a refueling was 150°F. That calculation was based on design outside air conditions. With the rerack of the SFPs, the peak SFP temperature during a refueling increased to 180°F. The calculation was revised, crediting outside air conditions that would exist during refueling months, and concluded that the design (Fuel Handling Building) FHB room temperature of 105°F would be maintained with the FHV System operating and a SFP temperature of 180°F.

The FHB exhaust air conditions resulting from a SFP temperature of 180°F do not impact the ability of the ventilation system to perform its design function. There are no active components in the SFP room. The exhaust filtration units and exhaust fans, which are downstream of the filtration units, are located outside the FHB in the Mechanical Penetration Area. The air from the SFP room mixes with air from other rooms in the FHB before entering the exhaust filtration units (refer to Salem UFSAR Figures 9.4-3A and B). With a SFP temperature of 180°F, the dew point of the air mixture is above the ambient air temperature in the Penetration Area, and thus there is a potential for condensation. However, with natural convection on the outside of the duct and filtration units, the dominant thermal resistance term between the ambient air and exhaust air flow is the convective resistance between the ambient air and the outside wall. Thus the difference in temperature between the inside wall and bulk fluid flow will be small, and condensation will be minimal. Any condensation would form on the walls of the duct and inlet plenum, collect on the floor, and then be directed to equipment drains beneath the filtration units.

The HEPA and charcoal filters are designed to perform under 100% relative humidity. Some condensation may form initially on the fan blades, but will eventually dissipate as the blades heat up. Also, the heatup of the SFP to 180 °F is gradual and of limited duration, and thus the heatup of the exhaust air will be gradual. As such any condensation on the fan blades will be minimal, and will not impact fan operation.

Therefore, the FHV System will remain functional in the FHB ambient air environment at SFP temperatures up to 180 °F.