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SUSQUEHANNA STEAM ELECTRIC STATION
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REGARDING CHANGE OF TECHNICAL SPECIFICATION
FOR ULTIMATE HEAT SINK AVERAGE TEMPERATURE
(TAC NOS. MA0342 AND MA0343) **Docket Nos. 50-387**
PLA-4991 **and 50-388**

Reference: 1) Letter dated September 8, 1998 from V. Nerses, Senior Project Manager, NRC, to R. G. Byram, Senior Vice President-Generation, PP&L, "Request for Additional Information (RAI) Regarding Change Of Technical Specification For Ultimate Heat Sink Average Temperature for the Susquehanna Steam Electric Station, Units 1 and 2."

2) PLA-4903 "Proposed Amendment No. 220 To License NPF-14 And Proposed Amendment No. 182 To License NPF-22: Ultimate Heat Sink Average Temperature," dated June 1, 1998.

The purpose of this letter is to respond to your Request for Additional Information (RAI), Reference (1), regarding our proposed change to the Technical Specification (TS) surveillance requirements for spray pond average water temperature for Susquehanna Steam Electric Station (SSES) Units 1 and 2, submitted via Reference (2). The specific RAI questions and our responses thereto are contained in Attachment 1.

1/1

If you require any clarification regarding the attached responses, please contact Mr. J. M. Kenny at (610) 775-7535.

A001

Sincerely,

G. T. Jones

G. T. Jones

Attachments

copy: NRC Region I
NRC Acting Sr. Resident Inspector, SSES
Mr. V. Nerses, NRC Sr. Project Manager
Mr. K. Kerns, Pennsylvania DEP/BRP

ATTACHMENT 1 TO PLA-4991

RESPONSE TO REQUEST
FOR ADDITIONAL INFORMATION

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ULTIMATE HEAT SINK AVERAGE TEMPERATURE

Background

By letter dated June 1, 1998,[1] PP&L proposed to change the Technical Specifications (TS) Surveillance Requirements for Susquehanna Steam Electric Station (SSES) Units 1 and 2. The change would replace the current spray pond average water temperature value of 88°F with a set of more restrictive values of 85°F, 87°F or 88°F, depending on whether either Unit has been in Mode 3: less than 12 hours; at least 12 hours but less than 24 hours; or at least 24 hours, respectively, with the other Unit in Mode 1 or 2.

The proposed graduated limits are intended to further restrict average spray pond water temperature to account for more accurate decay heat estimates used in ultimate heat sink (UHS) analyses.

A prior request,[2] which was superseded by the present request, would have established a single value of 85°F for all combinations of Unit operations. The present request recognizes and takes credit for the lower reactor decay heat rate 12 hours or more after shutdown and 24 hours or more after shutdown, compared to the reactor decay heat rate during the first 12 hours following shutdown.

The UHS consists of a Seismic Category I, concrete-lined spray pond covering an area of approximately 8 acres and containing approximately 25 million gallons of water, and a Seismic Category I intake structure housing four residual heat removal service water (RHRSW) system pumps and four emergency service water (ESW) system pumps combined with the associated piping and heat exchange equipment.[3] Water is pumped from the spray pond through the ESW and RHRSW loops back to the spray pond. The water returns to the spray pond through either a network of piping to a set of spray arrays and nozzles positioned above the spray pond surface or directly to the spray pond through spray bypass lines. The overall, safety-related function of the UHS is to provide an adequate source of water to the ESW and RHRSW pumps, at or below the ESW and RHRSW design temperature, so that the ESW and RHRSW systems can perform their intended design function during normal, transient and accident conditions. The UHS is designed to perform this function for the assumed transient or accident period of 30 days, assuming no makeup.

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[1] PLA-4903 "Proposed Amendment No. 220 To License NPF-14 And Proposed Amendment No. 182 To License NPF-22: Ultimate Heat Sink Average Temperature," dated June 1, 1998.

[2] PLA-4638, "Proposed Amendment No. 206 To License NPF-14 And Proposed Amendment No. 171 To License NPF-22: Ultimate Heat Sink Average Temperature," dated November 26, 1997.

[3] Pennsylvania Power & Light Company, DBD-009, 'Emergency Service Water, Residual Heat Removal Service Water and Ultimate Heat Sink'.

The design of the UHS is confirmed by performing two types of analyses: (1) a maximum water loss (MWL) analysis and (2) a minimum heat transfer (MHT) analysis. These analyses are based on NRC guidance[4] and establish: (1) the required initial mass of water in the UHS such that, under the worst case conditions for water loss (high wind speed coupled with high spray efficiencies), there remains a sufficient mass of water in the UHS 30 days following an accident; and (2) the required initial spray pond temperature such that, under the worst possible spray cooling conditions (zero wind speed coupled with low spray cooling efficiencies), the design basis temperature for the ESW and RHRSW system is not exceeded. The conservatism in these design calculations is discussed in detail in the responses to the NRC Request for Additional Information (RAI).

Following are the questions forwarded by the NRC RAI along with the SSES responses.

Question 1.
Discuss the analyses performed to demonstrate the impacts of the elevated average UHS water temperature on safety-related systems (i.e., shutdown cooling systems, emergency core cooling systems, containment systems, suppression pool, emergency diesel generators, etc.) for each of the above scenarios. Information to be provided should also include existing containment (drywell and wetwell) design temperature and pressure and the calculated containment peak and long-term temperatures and pressures following a loss-of-coolant accident for the above scenarios.

Response 1.
The present License Amendment request does not alter the current 97°F design temperature for the Residual Heat Removal Service Water (RHRSW) or Emergency Service Water (ESW)[5] systems or affect the capability of those systems to handle their design basis heat loads. Consequently, it does not affect the specific systems and equipment that make up those heat loads (i.e., shutdown cooling systems, emergency core cooling systems, containment systems, suppression pool, emergency diesel generators, etc.). Also, there is no impact from the requested change on containment (drywell and wetwell) design temperature and pressure and the calculated containment peak and long-term temperatures and pressures following a loss-of-coolant accident for the above scenarios.

The Licensing Topical Report,[6] which was submitted in support of the SSES Power Uprate with Increased Core Flow,[7] addressed heat loads on the RHRSW and ESW systems. The calculated ESW heat load on the spray pond was not affected by the power uprate because the rated capacities for the various ESW heat exchangers had been used in the original spray pond safety

[4] United States Nuclear Regulatory Commission, Regulatory Guide 1.27, 'Ultimate Heat Sink for Nuclear Power Plants', Rev. 2, January 1976.

[5] Also known as Engineered Safeguards Service Water (ESSW).

[6] Licensing Topical Report for Power Uprate with Increased Core Flow, NE-092-001A, PLA-3788, 6/15/92, as revised, PLA-3948, 4/2/93.

[7] Amendments Nos. 143 and 103 to SSES Units 1 and 2, dated February 22, 1995 and April 1, 1994, respectively

analyses. As stated in the power uprate topical report, "...the ESW heat exchangers can satisfy the uprated power cooling requirements at the new design temperature of 97°F."[8] Containment performance results, as summarized in Table 4-1 of the Licensing Topical Report, are not affected by the present request.

Question 2.
Discuss the procedures to be used by the SSES staff to monitor and control the UHS water temperature so as to remain within the design basis limiting values. Discuss and justify the location of needed instrumentation for monitoring the average UHS temperature. Also, discuss the effects of UHS temperature instrument uncertainties on the systems and components that interface with the UHS.

Response 2.
(The response is divided into three parts, corresponding to the three parts of the question.)

Discuss the procedures to be used by the SSES staff to monitor and control the UHS water temperature so as to remain within the design basis limiting values.

Seven resistance temperature detectors (RTDs) are used to monitor spray pond temperature. Four of these RTDs are in the spray network areas and provide only surface temperature. The remaining three RTDs are in a vertical array just outside of the ESSW pump house and provide surface, middle and bottom temperature inputs to the average temperature calculation. Spray pond temperature from the latter three RTDs is recorded four times a day in the shiftly surveillance log.[9] An individual reading is recorded for each of the 3 levels, and an average value is calculated manually. If the average temperature exceeds the limit specified in TS SR 3.7.1.2, compliance with the conservative Required Action of TS LCO 3.7.1, Condition C, is required. Prior to reaching the TS limit, however, the spray pond temperature monitoring system is designed to actuate an alarm in the Control Room, as well as an alarm in the ESSW pumphouse. Each alarm occurs if its input temperature reaches 83°F. The alarms are discussed in more detail below.

The ESW and RHRSW operating procedures provide guidelines for the operation of the UHS sprays and spray bypass lines based on spray pond temperature and ambient conditions. The spray pond temperature instruments are not used to automatically initiate any accident or transient prevention or mitigation function. However, operator action to reduce spray pond temperature is required any time a spray pond high temperature alarm is received. Operator action required by the alarm procedures specifies, in part, checking spray pond temperature, ensuring proper system alignment, and circulating water through the system to the spray nozzles per the ESW or RHRSW operating procedure, as well as complying with the Technical Specifications.

[8] Topical Report, op. cit., Section 6.4.1.1.1
[9] This is 4 times the required TS SR 3.7.1.2 frequency of once per 24 hours.

Applicable emergency procedures require that plant conditions be monitored to identify potential long-term operational impacts.[10] Specifically, when spray pond temperature is approaching or is above 85°F, operations personnel must provide verification that the spray bypass valves are closed. Additionally, the procedures require that emergency personnel ensure the spray inlet valves are operated in accordance with operating procedures for the aligned RHRSW/ESW loop flow. Amplifying instructions emphasize the importance of properly aligning the spray pond and bypass valves to ensure the spray pond temperature remains within its design value of 97°F.

Discuss and justify the location of needed instrumentation for monitoring the average UHS temperature.

The three RTDs installed just outside of the ESSW pump house are used to calculate the average spray pond temperature. The four RTDs in the spray network areas monitor only surface temperature. All of the RTDs provide input to spray pond temperature alarms. The four surface RTDs in the spray network areas provide input to the alarm in the Control Room, and all seven RTDs provide input to the alarm in the ESSW pumphouse. As mentioned above, each alarm occurs if its input temperature reaches 83°F. In addition, actuation of the pumphouse alarm causes a trouble alarm in the Control room.

The five RTDs that perform surface temperature detection are positioned to allow for slight water level fluctuations without loss of function. All five of these RTDs are located at elevation 678'—0", just below the water surface elevation required by TS.[11] As stated in the SSES TS Bases Section 3.7.1.2, the UHS temperature is the "...arithmetical average of the UHS temperature near the surface, middle and bottom levels...." The "middle" RTD is at elevation 672'—0", and the "bottom" sensor is at elevation 667'—0". All three elevations currently are monitored and recorded by operators four times per day, and an average value is calculated each time.

The intent of the three-detector array (near the ESSW pumphouse) is to approximate the average ("bulk") temperature of the spray pond water. If the spray pond water were reasonably well mixed, *e.g.*, during surveillance testing of the ESW pumps, little difference would be expected in average temperature as calculated using the detector array or as determined by a single bulk temperature detector. On the other hand, if some temperature gradient or stratification existed, the 3-level array would be more likely to yield a representative estimate of the average bulk temperature than a single bulk temperature detector.

[10] Emergency Plan Position Specific Procedure EP-PS-102, Tabs J and 10.
[11] TS SR 3.7.1.1, 678 feet 1 inch above Mean Sea Level.

Discuss the effects of UHS temperature instrument uncertainties on systems and components that interface with the UHS.

Spray pond temperature instrument uncertainties are not expected to have any significant effect on systems and components that interface with the UHS. No trips or automatic safety or protective functions are dependent on spray pond average temperature indication or alarm. The UHS high temperature alarm is set 2°F below[12] the lowest of the 3 average temperature limits proposed in the present request and is actuated by any of the 7 installed RTDs. The accuracy and drift are approximately ±0.65°F and ±0.03°F, respectively, for this model of RTD.[13] The effects of RTD accuracy and drift on surface monitoring and alarm functions are minimized by the use of multiple RTDs for this purpose.

The effects of spray pond temperature instrument uncertainties on systems and components that interface with the UHS are further minimized by the inclusion of conservatism in the UHS analyses. FSAR section 9.2.7.3 discusses conservatism in the minimum heat transfer (MHT) and maximum water loss (MWL) analysis models. The results of these analyses confirm the ability of the UHS to meet its design basis function of providing sufficient cooling water without makeup to the spray pond for at least 30 days to permit safe shutdown and cooldown of both units under a variety of circumstances, up to and including a design basis loss-of-coolant accident in one unit and a simultaneous shutdown of the second unit.

Significant conservatism, although not quantified, was included in the UHS analyses by following Regulatory Guide (RG) 1.27 and Branch Technical Position ASB 9-2.[14] Additional conservatism, as discussed below, was provided by specific analytical methods and assumptions utilized in the analyses.

Conservatism in the MWL and MHT analyses is as follows (regulatory or analytical).

1. Worst case meteorological conditions and timing are applied for each analysis—this maximizes water loss from the spray pond for the MWL analysis and minimizes heat transfer to the environment for the MHT analysis. (regulatory)
2. No water addition from rain is assumed—no credit is taken for natural water makeup from rainfall in the MWL analysis (regulatory) or for the cooling effect on the pond temperature from rainfall in the MHT analysis. (analytical)

[12] Nominal value. Allowing for loop inaccuracy and RTD drift, the alarm setpoint for a given RTD is 1.2°F below the temperature limit.

[13] Rosemount Model 88; based on vendor information. Accuracy based on interpolation between ± 0.468 at 32°F and ±0.954 at 212°F; drift 0.08% of ice point (32°F) after 1000 hours of operation at max rated temperature of 400°C.

[14] NUREG-75/087, Standard Review Plan, Section 9.2.5

3. The worst case single failure is assumed—the failure of a spray pond bypass valve to shut automatically on demand removes one-half of the spray cooling arrays from service in the MHT analysis, and returns heated water to the pond without spraying. (regulatory) No credit is taken for evaporative cooling of this bypassed flow in the spray pond. (analytical)
4. The worst-case operating equipment heat load is assumed in the MHT analysis—this maximizes heat deposited into the UHS. (regulatory)
5. The worst case diesel-generator heat load is assumed in the MHT analysis—this maximizes heat deposited into the UHS. (regulatory)
6. The worst case wind speed is assumed—low wind speed minimizes spray heat transfer in the MHT analysis,[15] and high wind speed[16] maximizes water loss in the MWL analysis. (regulatory)
7. A conservative drift loss model is applied—this maximizes the loss of water spray droplets from the pond in the MWL analysis due to maximizing the time a droplet is in the air above the elevation necessary for it to be lost from the pond. (regulatory)
8. A conservative thermal efficiency model is applied—this minimizes heat transfer in the MHT analysis by assuming no drag on water droplets in the air and, thus, minimizing their time exposed to the air for heat transfer. (regulatory)
9. A worst case spray pond surface area available for evaporative water loss is assumed—this assumes no sprays in operation to shield the pond surface from evaporation in the MWL analysis and increases estimated mass loss by about 10%. (analytical)
10. A worst case initial spray pond level is assumed—the maximum pond level (678'-6") minimizes heat transfer for the MHT analysis by reducing the distance that spray droplets travel through air from the nozzles back to the pond surface; while the minimum pond level (678'-1") minimizes the available water inventory assumed for the MWL analysis.[17] (analytical)
11. The worst case ESW/RHRSW system alignment is assumed in the MHT analysis—this maximizes heat deposited into the UHS. (analytical)
12. No ambient heat loss through the concrete basin is assumed—this minimizes heat rejected from the spray pond to the environment in the MHT analysis. (analytical)
13. No heat transfer to ESW or RHRSW piping or components is assumed—this minimizes heat rejected from the ESW and RHRSW systems in the MHT analysis. (analytical)
14. No single failure of cooled equipment is assumed in the MHT analysis—this maximizes the equipment heat load rejected into the ESW/RHRSW systems. (analytical)

[15] A wind speed of zero was used for the analysis.
[16] Based on the maximum historical average 3-day wind speed profile.
[17] The RHRSW Operating Procedure normally ensures spray pond level is ≥678'-6".

15. Maximum design siphoning water loss is assumed through the deicing lines. (analytical)
16. Maximum design spent fuel pool makeup of 70 gpm is assumed. (analytical)
17. All pump energy is assumed deposited into the working fluid in the MHT analysis. (analytical)

In addition to the above conservatism, a measurement error allowance of 0.5°F is included in UHS analyses for the initial average spray pond water temperature.

We have estimated the margins in peak spray pond temperature and the corresponding margins in initial average temperature provided by several of the above MHT assumptions, choosing only from those assumptions that apply to temperature margin and that are not explicitly recommended by regulatory guidance. The estimated margins, as summarized in the following table, more than offset documented spray pond temperature measurement uncertainty.

Item	Basis for Margin Estimate	Estimated Margin in Calculated Peak UHS Temperature (°F)	Estimated margin in Initial Avg. UHS Temperature (°F) [18]
10	Calculation	0.15	0.9
11	Integrated heat input (same order of magnitude as Item 17)	0.1	0.6
12	Calculational estimate based on heat transfer potential	0.3—0.6	1.8—3.6
13	Calculational estimate (same order of magnitude as Item 17)	0.1	0.6
17	Integrated heat input based on assumed 95% pump efficiency rather than 100%	0.1	0.6
Total	—	**0.75—1.05**	**4.5—6.1**

As can be seen from the above table, based on conservative analytical assumptions, there is a clear margin in calculated peak UHS temperature and a considerable margin in the initial average UHS temperature limit necessary to keep peak UHS temperature within design basis limits. The latter margin easily bounds the spray pond temperature instrumentation design accuracy of ±2°F.[19]

[18] An increase of 1°F in initial average spray pond temperature translates to approximately 0.16°F in calculated peak spray pond temperature.

[19] ±2% of 100°F per SSES FSAR Table 7.5-6

Furthermore, the spray pond temperature channels are regularly calibrated in the SSES preventive maintenance program. Based on a review of the calibration records for the loops used to calculate average temperature for the ten year period that includes the most recent (1996) calibrations, the maximum as-found loop inaccuracy has not exceeded the stated design accuracy of ±2°F. Only twice during that period has the as-found inaccuracy for any of these loops been as much as ±1.25°F, and that was in the conservative direction.[20] Even adding RTD accuracy and drift (±0.70°F), as previously discussed, to the worst as–found temperature loop accuracy (±1.25°F), yields overall accuracy within the stated FSAR design accuracy of ±2°F.

Summarizing the key points of the above Responses:

- The present request does not alter the current 97°F UHS design temperature limit for the ESW and RHRSW systems.
- No automatic trips or automatic safety or protective functions are dependent on spray pond temperature indications or alarms.
- Operating, surveillance, alarm and emergency procedures provide specific instructions for maintaining UHS temperature within design limits.
- Average Spray Pond temperature currently is determined at four times the frequency required by the TS, and TS Required Actions provide a conservative response to high temperatures.
- The design of the SSES Spray Pond temperature monitoring system provides multiple inputs to temperature measurements and alarms and includes a substantial margin between the high temperature alarm setpoint and the TS temperature limit.
- All of the temperature detectors used in the Spray Pond temperature monitoring system are RTDs, and all provide input to high temperature alarms.
- Clear margins have been demonstrated in calculated peak UHS temperature and in the initial average UHS temperature using analytical conservatism, and these margins more than offset the effects of variations in measured or calculated temperature due to instrument inaccuracy.
- Periodic calibration of the Spray Pond temperature loops, when combined with RTD accuracy and drift estimates, confirms that instrument accuracy is within FSAR design bases and ensures continued acceptable accuracy.
- Analytical conservatism used to demonstrate temperature margins is in addition to conservatism provided by applying regulatory guidance, which, if also credited, would result in substantially more margin to any impact on equipment that interfaces with the UHS.

[20] 1993, Temperature loops T-01228E (Surface) and G (Bottom), as-found, conservatively indicated 88.75°F for an input of 87.5°F.