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U. S. Nuclear Regulatory Commission
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SUSQUEHANNA STEAM ELECTRIC STATION
PROPOSED LICENSE AMENDMENT NO. 285
FOR UNIT 1 OPERATING LICENSE NO. NPF-14
AND PROPOSED LICENSE AMENDMENT NO. 253
FOR UNIT 2 OPERATING LICENSE NO. NPF-22
EXTENDED POWER UPRATE APPLICATION
RE: BALANCE-OF-PLANT SAFETY SYSTEMS **Docket Nos. 50-387**
REQUEST FOR ADDITIONAL INFORMATION RESPONSES **and 50-388**
PLA-6198

References: 1) PPL Letter PLA-6076, B. T. McKinney (PPL) to USNRC, "Proposed License Amendment Numbers 285 for Unit 1 Operating License No. NPF-14 and 253 for Unit 2 Operating License No. NPF-22 Constant Pressure Power Uprate," dated October 11, 2006.

2) Letter, R. V. Guzman (NRC) to B. T. McKinney (PPL), "Request for Additional Information (RAI) – Susquehanna Steam Electric Station, Units 1 and 2 (SSES 1 and 2) - Extended Power Uprate Application Re: Balance-Of-Plant Safety Systems Review (TAC Nos. MD3309 and MD3310)," dated April 16 2007.

3) Letter, R. V. Guzman (NRC) to B. L. Shriver (PPL) "Susquehanna Steam Electric Station, Units 1 & 2 - Generic Letter 96-06, 'Assurance of Equipment Operability and Containment Integrity During Design Basis Accident,' (TAC Nos. MB96875 and MB96876)," dated August 12, 2003.

Pursuant to 10 CFR 50.90, PPL Susquehanna LLC (PPL) requested in Reference 1 approval of amendments to the Susquehanna Steam Electric Station (SSES) Unit 1 and Unit 2 Operating Licenses (OLs) and Technical Specifications (TS) to increase the maximum power level authorized from 3489 Megawatts Thermal (MWt) to 3952 MWt, an approximate 13% increase in thermal power. The proposed Constant Pressure Power Uprate (CPPU) represents an increase of approximately 20% above the Original Licensed Thermal Power (OLTP).

The purpose of this letter is to provide responses to the Request for Additional Information transmitted to PPL in Reference 2.

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The Enclosure contains the PPL responses.

There are no new regulatory commitments associated with this submittal.

PPL has reviewed the "No Significant Hazards Consideration" and the "Environmental Consideration" submitted with Reference 1 relative to the Enclosure. We have determined that there are no changes required to either of these documents.

If you have any questions or require additional information, please contact Mr. Michael H. Crowthers at (610) 774-7766.

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

Executed on: May 14, 2007

for B. T. McKinney

Enclosure: Request for Additional Information Responses

Copy: NRC Region I
Mr. A. J. Blamey, NRC Sr. Resident Inspector
Mr. R. V. Guzman, NRC Project Manager
Mr. R. R. Janati, DEP/BRP

Enclosure to PLA-6198

PPL EPU

Request for Additional Information Responses

NRC Question 1:

Section 6.3 of the Susquehanna Power Uprate Safety Analysis Report (PUSAR) states that "during refueling conditions, the three FPCCS heat exchangers in the outage unit are typically supplied with river water with an assumed maximum river temperature limit of 75°F." Table 6-4 and 6-5 of the report indicate that 75°F cooling water temperatures were used for these heat exchangers in analyses in which the maximum SFP cooling bulk water temperature and time to boil were calculated. The results presented are only bounding provided 1) river water is used as the supply, and 2) the river water temperature does not exceed the 75°F temperature limit.

a) In section 9.1.3.2 of the Susquehanna Final Safety Analysis Report (FSAR), the potential to use river water to cool SFP cooling heat exchangers for the refueling unit or temporary cooling tower chillers are discussed. However, the use of river water at 75°F does not appear to be credited for maintaining the pool below its design temperature of 125°F. For the current licensing basis, please provide the inputs, assumptions and results used in the fuel pool cooling analysis. Your response should include the information contained in Tables 6-4, and 6-5 of the PUSAR.

b) Provide the basis for use of the 75°F temperature used in your EPU SFP cooling analysis.

c) Provide a discussion of administrative and/or procedural controls that will ensure that the assumed conditions (river water at or below 75°F will supply the three FPCCS heat exchangers of the outage unit) are met prior to the start of refueling, or that a cycle specific evaluation is performed to confirm that pool temperature limits will not be exceeded.

PPL Response 1a:

During two-unit operation and refueling outages, the SSES fuel pools are normally cross-connected, with each units Service Water System supplying three Fuel Pool Cooling and Cleanup System (FPCCS) heat exchangers. In addition, the Residual Heat Removal Fuel Pool Cooling Assist mode (RHRFPC) is available as a backup to the FPCCS.

For purposes of performing bounding licensing-basis analyses (as discussed in PUSAR Section 6.3), one unit is assumed to be in a refueling outage. The FPCCS heat exchangers in the non-outage unit are supplied with service water, with a maximum allowed temperature of 95°F. The FPCCS heat exchangers in the outage unit are supplied with River Water at an assumed maximum temperature of 75°F. These assumed temperatures are very conservative and are well above temperatures that are actually experienced during spring-time outages, as described in response to item b below.

The plant conditions Tabulated in Table 6-4 of the PUSAR represent up-rated batch heat loads (Rated Thermal Power [RTP] of 3952 MWt) for decay heat loads at 144 and 69.6 hours after plant shutdown. At 144 hours (6 days) after reactor shutdown, 20.3 MBTU/hr results from the batch offload plus 8.5 MBTU/hr is conservatively assumed from the resident fuel in both pools, for a total heat load of 28.8 MBTU/hr. A second case is evaluated at 69.6 hours, assuming fuel movement begins 24 hours after reactor shutdown, for a total combined heat load of 34.6 MBTU/hr.

The total decay-heat load is compared against the heat removal capacity to ensure that licensing basis (125°F) and administrative (115°F) Spent Fuel Pool (SFP) temperature limits can be maintained with cooling water at 75°F to three FPCCS heat exchangers and 95°F to three FPCCS heat exchangers.

The plant conditions tabulated in Table 6-5 represent a full-core offload (defined as an emergency heat load EHL) completed in 11 days after reactor shutdown. Total decay heat is based on cross connected pools with decay heat in one pool from a partial core at EPU, 16.4 days after reactor shutdown, projected to be 14.7 MBTU/hr. Decay heat from a full core in the other pool at EPU is projected to be 39.1 MBTU/hr. The background heat from spent fuel resident in both pools is approximately 8.5 MBTU/hr. Total EHL in the cross-tied SFPs = 14.7 + 39.1 + 8.5 = 62.3 MBTU/hr.

The EHL heat load can be removed from both SFPs to maintain the combined pool temperature below 125°F. This can be accomplished with three FPCCS heat exchangers with cooling water at a maximum of 75°F, three FPCCS heat exchangers supplied with 95°F, and one RHRFPC mode heat exchanger supplied with 88°F (from the Ultimate Heat Sink). Cooling water at 88°F is assumed since it is the maximum temperature allowed by Technical Specifications.

Key parameters tabulated in PUSAR Tables 6-4 and 6-5 are shown below:

<u>Table 6-4</u> *Batch Offload SFP at the FSAR temperature limit of 125°F*

Based on minimum flows to the FPCCS heat exchangers, the FPCCS heat transfer coefficient Keff was calculated to be 40.8 Btu/°F-sec.

<u>Condition 1</u>: Three FPCCS heat exchangers with 1000 gpm at 75°F and three FPCCS heat exchangers with 1000 gpm at 95°F:

FPCCS can remove:

Q = 40.8 Btu/°F x (125°F-95°F) x (3600 s/hr) x 3 = 13.20 MBTU/hr.
Q = 40.8 Btu/°F x (125°F-75°F) x (3600 s/hr) x 3 = 22.04 MBTU/hr.

TOTAL HEAT REMOVAL = 35.2 > 28.8 MBTU/hr

SFP temperature is maintained below 125°F.

Condition 2: Three FPCCS heat exchangers with 1000 gpm at 75°F and two FPCCS heat exchangers with 1000 gpm at 95°F:

FPCCS can remove:

Q = 40.8 Btu/°F x (125°F-75°F) x (3600 s/hr) x 3 = 22.04 MBTU/hr.
Q = 40.8 Btu/°F x (125°F-95°F) x (3600 s/hr) x 2 = 8.81 MBTU/hr.

TOTAL HEAT REMOVAL = 30.8 > 28.8 MBTU/hr

SFP temperature is maintained below 125°F.

Table 6-5 *Full Core Offload SFP at the FSAR temperature limit of 125°F*

Based on minimum flows to the RHR heat exchangers, the RHR heat transfer coefficient Keff was calculated to be 265.0 Btu/°F-sec. Assuming (1) RHR heat exchanger is supplied with 88°F, the full core heat removal capacity is:

Three FPCCS heat exchangers with 1000 gpm at 75°F and three FPCCS heat exchangers with 1000 gpm at 95°F and one RHR HX with 8000 gpm at 88°F:

Heat removed is:

Q = 40.8 Btu/°F-sec x (125°F-95°F) x (3600 s/hr) x 3 =13.20 MBTU/hr.
Q = 40.8 Btu/°F-sec x (125°F-75°F) x (3600 s/hr) x 3 = 22.04 MBTU/hr.
Q = 265 Btu/°F-sec. x (125°F-88°F) x (3600 s/hr) = 35.3 MBTU/hr.

TOTAL HEAT REMOVAL = 70.5 > 62.3 MBTU/hr

SFP temperature is maintained below 125°F.

PPL Response 1b:

The maximum river temperature used in the above design-basis analyses is conservatively selected as 75°F based on refueling outages that are scheduled each spring (specifically in March). Five years worth of data from the early 1990s was evaluated. Data from the relatively mild winter of 1995 was selected as being conservatively representative of March temperatures. The average minimum, mean, and maximum river temperatures during March 1995 were determined to be 33°F / 41°F / 48°F respectively. Also, the mean river temperature for the month of April 1995 was 50°F and maximum river temperature didn't reach 75°F until June 3rd. Consequently, the assumption that river water temperature during a spring (March) refueling outage would remain below 75°F is considered to be conservative.

As shown above, 95°F service water and 75°F river water are assumed for purposes of analyses that demonstrate system and equipment capabilities. Temperatures are typically around 75°F service water and 50°F river water. As shown in the response to question c) below, procedural controls are in place to assure that bulk pool temperatures remain below established limits. Consequently, the 75°F river temperature is not an actual limit but is rather a conservative assumption used for purposes of licensing basis analyses. The actual limits for a specific outage are governed by plant procedures.

PPL Response 1c:

As stated in response to question b) above, the 75°F river water temperature assumption is not controlled by plant procedures. However, cycle specific procedures assure compliance with pool temperature limits.

The expected SFP decay heat is calculated each outage. The expected decay heat is then used to predict the heat loads, corresponding time-to-boil, and peak temperatures for the fuel pools and reactor vessel for any given day of the outage. Calculation identifies the minimum equipment lineup required to ensure bulk fuel pool temperature will be maintained less than the administrative limit 115°F given the expected decay heat load. This administrative limit provides margin to the pool licensing temperature limit of 125°F. Plant procedures require verification that the heat capacity bounds the actual decay heat load and if not, assure they are revised for the outage-specific conditions.

NRC Question 2:

In evaluating the impact of postulated failures, typically the failure of active equipment is postulated. In Table 6.4 and 6.5 of the PUSAR postulated failure of heat exchangers (passive equipment) are shown. Please discuss what effect failure of active equipment such as the failure of a FPCCS pump would have on the heat removal capacity and the resultant pool temperature.

PPL Response:

Active failures are bounded by the condition that results in loss of all FPCCS. This scenario is postulated based on the non-safety related, non-seismic, non-Class 1E power design specification for FPCCS. As such, seismic or Loss of Power (LOP) events may result in complete loss of all FPCCS. Should this occur, pool boiling is precluded because administrative and licensing temperature limits have been established to assure that sufficient time is available (a minimum of 25 hours) to initiate at least one RHR heat exchanger in the RHRFPC mode. Since the safety-related RHR systems of both units are capable of cooling the cross-connected spent fuel pools, and since either of two RHR heat exchangers per unit can be aligned to the RHRFPC mode, each with two redundant pumps, no active failure can prevent initiation of the RHRFPC mode.

In addition to the above, the analyses assuming postulated failures reflected in Tables 6.4 and 6.5 are simplified by considering failures of heat exchangers rather than pumps. Since the FPCCS contains three heat exchangers and three pumps, loss of one pump is bounded by loss of one heat exchanger. Two FPCCS pumps aligned to three heat exchangers can provide more total cooling than two pumps aligned to two heat exchangers. However, if this was not the case, one of the heat exchangers could be manually isolated leaving two pumps and two heat exchangers. Therefore, analyzing failures based on removal of heat exchangers is equivalent to analyzing based on the removal of pumps.

NRC Question 3:

Section 6.1.4 of the PUSAR addresses the impact of EPU on the service water system; however, it fails to address any effects of Generic Letter (GL) 96-06. Please describe any impacts that the proposed EPU will have on the issues discussed in GL 96-06, "Assurance of Equipment Operability and Containment Integrity during Design Basis Accident Conditions," and GL 96-06 Supplement 1 including the basis for your determination. In particular, confirm that water hammer and two-phase flow analysis that were completed in accordance with GL 96-06 continue to be valid.

PPL Response:

NRC Generic Letter 96-06 identified two concerns regarding the operability of containment air cooling systems during Design Basis Accident (DBA) accident conditions: 1) the potential for water hammer, which could damage piping; and, 2) the potential for two-phase flow, which could reduce the effectiveness of containment cooling.

The containment air cooling system at Susquehanna is a non-safety-related system, which is used for drywell cooling during normal power operations. In the event of a design basis Loss of Coolant Accident (LOCA), the system automatically isolates due to low vessel level, or high drywell pressure. Since the drywell coolers automatically isolate via redundant isolation barriers during design basis accidents, two-phase flow will not occur. In addition, since the drywell coolers are not credited for the containment heat removal function during design basis LOCA scenarios, the effects of potential two-phase flow on the effectiveness of the coolers is of no consequence.

In addition, Susquehanna's Emergency Operating Support Procedures, which govern the recovery of the drywell cooling system under severe accident scenarios, prohibit the restoration of the drywell coolers when plant conditions indicate that a LOCA has occurred.

PPL's resolution of the GL was reviewed by the NRC and accepted in Reference 3. As discussed in Section 4.1.6 of the PUSAR, PPL's original responses to Generic Letter 96-06 have been reviewed for CPPU post accident conditions. These NRC reviewed and accepted responses are unaffected and remain valid for CPPU.

NRC Question 4:

Section 6.4.5 of the Susquehanna PUSAR it is stated that "The average nozzle flow rate, in turn, will allow confirmation that the analytical assumptions for nozzle pressure and spray height are conservative based on known correlations between flow and spray." Please explain how modification testing will be used to verify that the actual height of spray from the most limiting (lowest pressure) nozzle is consistent with the analytically modeled spray height results.

PPL Response:

The Ultimate Heat Sink (UHS) performance at design basis conditions is predicted using two thermal performance models (Low Wind Speed (LWS) and High Wind Speed (HWS)). The spray arrays were tested in July 1983 to compare measured test data to thermal performance model predictions. For this test, the spray arrays were operated with a heat load from Unit 1. Ambient conditions were recorded along with the temperature of RHRSW/ESW before and after spraying. Spray efficiencies were then calculated based on the measured ambient conditions using the thermal performance models.

For low wind speed conditions (wind speeds below 4.5 mph), the measured sprayed water temperature was shown to be lower than the sprayed water temperature predicted. This demonstrated the conservatism in the Minimum Heat Transfer (MHT) analyses at low wind speeds. Therefore, the LWS is used for the MHT analyses.

For wind speeds above 4.5 mph, measured sprayed water temperatures were generally higher than those predicted by the model. This indicates that the cooling capability of the spray arrays is less than predicted. However, since spray cooling is directly related to spray evaporation, the high wind speed model predicts more evaporation losses than actually occur. The high wind speed model, therefore, is conservative in terms of spray evaporation losses. This model is thus used for the Maximum Water Loss analysis.

Refer to FSAR Section 9.2.7 for further discussion of the thermal performance models and field test results.

The calculation of spray cooling performance by both the performance models assumed that all nozzles operated at a pressure drop that corresponded to the average pressure drop for the spray array. Therefore, comparison between calculated spray cooling performance and the measured test data demonstrated that the thermal performance models conservatively predict spray performance when the average nozzle pressure drop is assumed. Since correlations exist for spray height as a function of nozzle pressure drop and measurement of the total spray array flow rate allows average nozzle pressure drop to be determined, confirmation of the average nozzle flow rate during post modification testing will be adequate confirmation of spray cooling capability. Based on this, modification testing does not need to be used to verify that the actual height of spray from the most limiting (lowest pressure) nozzle is consistent with the analytical spray height results.