Attachment 2 to PLA-6203
Non-Proprietary Version of the Request for Additional Information Responses

NRC Question 1:

(a) List and discuss all changes to analysis methods or assumptions between the EPU and the current licensing basis in the area of containment safety, and

(b) Verify that the assumptions of final safety analysis report (FSAR) Sections 6.2.1.1.3.3.1.1, 6.2.1.1.3.3.1.2, and 6.2.1.1.3.3.1.3 are used for the EPU analyses.

PPL Response:

1 (a)

Changes to analysis methods and assumptions in the area of containment safety, are as follows:

Short-Term reactor blowdown containment pressurization analysis – Recirculation Suction Line Break (RSLB)

Reactor Blowdown Model: Both the current licensing basis short-term CLTP analysis and the CPPU short-term CLTP analysis use the reactor vessel blowdown model of the LAMB code. [[

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Feedwater Coastdown: The current licensing basis short-term CLTP analysis assumes reactor feedwater flow into the vessel continues at a flow rate as provided in SSES FSAR Table 6.2-9a. The CPPU analysis assumes reactor feedwater flow into the vessel continues at full rated flow for the first ten (10) seconds following initiation of the event. [[

]] the assumption of full rated feedwater flow is more conservative because it results in a [[

]] more feedwater mass and energy addition to the drywell.

Short-Term containment pressurization analysis

Initial Containment Atmospheric Conditions: The current licensing basis short-term CLTP analysis assumes nominal initial containment pressure (0.5 psig) and relative humidity (48%) for calculation of the peak containment pressures following a DBA RSLB LOCA. The CPPU short-term CLTP analysis assumes a more conservative initial containment pressure (2.0 psig) and relative humidity (20%) for calculation of the peak containment pressures following a DBA RSLB LOCA. These more conservative initial conditions result in a [[

]] a higher pressure in the wetwell airspace and thus a higher peak pressure in the drywell.

Long-Term suppression pool temperature

Decay Heat Fractions: The current long-term analysis for peak bulk suppression pool temperature following a DBA LOCA uses decay heat fractions that are calculated using the ANS 5-1971 standard with +20%/10% margin for uncertainty. The SSES CPPU long-term analysis for peak suppression pool temperature following a DBA LOCA uses decay heat fractions that are calculated using the ANS 5.1-1979 standard with $+2\sigma$ margin for uncertainty. The staff's approval to use the ANS 5.1-1979 standard with $+2\sigma$ is requested in the Enclosure of PPL's CPPU license amendment request (Reference 1).

Passive Containment Heat Sinks: The current long-term analysis for peak bulk suppression pool temperature assumes no credit for passive heat sinks in the drywell, suppression chamber air space, or suppression pool. The CPPU analysis, however, credits passive heat sinks in the drywell, suppression chamber air space, and suppression pool. The staff's approval to credit passive heat sinks is requested in the Enclosure of PPL's CPPU license amendment request (Reference 1).

1 (b)

All of the assumptions of SSES FSAR Rev. 60 Sections 6.2.1.1.3.3.1.1, 6.2.1.1.3.3.1.2, and 6.2.1.1.3.3.1.3 are applicable to the CPPU analyses with the following exceptions:

6.2.1.1.3.3.1.1 Short-term RSLB Reactor Blowdown

FSAR Item (g): The current analysis assumes reactor feedwater flow into the vessel continues at a flow rate as described in SSES FSAR Table 6.2-9a. The CPPU analysis assumes reactor feedwater flow into the vessel continues at full rated flow rate for the first ten (10) seconds following initiation of the event. [[

]] more feedwater mass and energy addition to the drywell.

6.2.1.1.3.3.1.2 Short-term RSLB Containment Pressurization

All assumptions listed in this section of the SSES FSAR are confirmed to be used for the CPPU analysis.

6.2.1.1.3.3.1.3 Long-term RSLB Suppression Pool Heatup

FSAR Item (d): The current long-term suppression pool temperature analysis for RSLB assumes no credit for passive heat sinks in the drywell, suppression chamber air space, or suppression pool. The CPPU analysis, however, credits passive heat sinks in the drywell, suppression chamber air space, and suppression pool. The initial suppression pool mass used in both the current and CPPU analysis corresponds to the minimum low water level.

NRC Question 2:

In Attachment 4, "Power Uprate Safety Analysis Report (PUSAR) of your October 11, 2006, submittal, Section 4.1.1.1, (a) verify that Service Information Letter 636 Revision 1 was used when determining decay heat values and, (b) verify that the bulk pool temperature is calculated "based on" ANSI/ANS-5.1-1979," American National Standard for Decay Heat Power in Light Water Reactors," dated August 1979. What does the term "based on" imply? Are there modifications to this standard's methods for the Susquehanna EPU calculations?

PPL Response:

2(a)

PPL has verified that SIL 636 Rev. 1, with adders (due to actinides and activation products), was used in determining the decay heat values used in the CPPU containment analyses.

2 (b)

ANSI/ANS 5.1-1979 Standard (with SIL 636 Rev. 1 actinide and activation product adders) plus 2σ uncertainty margin was used to calculate the decay heat and the bulk suppression pool temperature for CPPU. The words "based on" were intended to indicate that the standard was followed to calculate the decay heat. There were no modifications to the standard's methods for SSES CPPU analyses. As stated in the response to Question 1(a) above, the staff's approval to use this standard is requested in the Enclosure of PPL's CPPU license amendment request (Reference 1).

NRC Question 3:

Table 4-1 of PUSAR: (a) explain what factors are responsible for the difference between the current licensed thermal power level (CLTP) peak drywell pressure and peak drywell temperature values from the FSAR and the CLTP peak drywell pressure and peak drywell temperature values calculated with constant pressure power uprate (CPPU) methods, (b) explain why the peak bulk pool temperature is reduced 11 degrees Farenheit

(°F) when the CPPU methods are used rather than FSAR methods, (c) explain the difference between the peak wetwell pressure values with FSAR and CPPU methods, (d) explain why the peak drywell-to-wetwell (down) differential pressure is reduced when using CPPU methods rather than FSAR methods, (e) what accounts for the increase in peak drywell pressure from CLTP to CPPU if the dome pressure remains almost constant (1050 pounds per square inch absolute (psia) vs. 1054 psia) and the same methods are used?

PPL Response:

3 (a)

The increase in peak drywell pressure is primarily due to a more conservative assumption of drywell and wetwell initial pressure. The analysis performed for the CLTP assumed an initial containment pressure of 0.50 psig, while the new CPPU analysis assumes an initial containment pressure of +2.0 psig; the maximum allowed per SSES Technical Specifications. This results in a [[

]] The analysis performed for the CLTP assumed an initial containment pressure of 0.50 psig, while the new CPPU analysis assumes an initial containment pressure of –1.0 psig; the minimum allowed per SSES Technical Specifications. [[
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3 (b)

The reduction in peak bulk SP temperature is primarily due to the use of the more realistic, but still conservative decay heat model. The CLTP/FSAR analysis used the ANS-5-1971 +20%/10%, while the CLTP/CPPU analysis uses ANS-5.1-1979 + 2σ. As previously stated in the responses to Questions 1(a) & 2(b) above, the staff's approval to use this standard is requested in the Enclosure of PPL's CPPU license amendment request (Reference 1).

3 (c)

The increase in peak wetwell pressure is primarily due to a more conservative assumption of drywell and wetwell initial pressures. See the response to Question 3(a) above.

3 (d)

The decrease in peak differential pressure is primarily due to the use of [[ ]] for calculating wetwell pressures associated with the pool swell phenomenon. See the discussion regarding the "Reactor Blowdown Model" response to Question 1(a) above.

3 (e)

The increase in peak drywell pressure from CLTP to CPPU is primarily due to the use of a more conservative assumption for feedwater injection following the initiation of the event. The CLTP with CPPU methods assumes a feedwater coast-down that begins to decrease from 100% rated flow at about 2.5 seconds to about 93% rated flow at 6.0 seconds, then begins to increase slightly to 95% rated flow at 9.0 seconds, then again decreases to about 51% rated flow at 26.1 seconds, increases to 53% rated flow at 31.5 seconds, then finally decreases to zero flow at and beyond 42.0 seconds. For CPPU however, a more conservative assumption is used that assumes feedwater continues to provide 100% rated flow for 10 seconds. Since the peak drywell pressure occurs between 8 and 9 seconds, continuation of feedwater flow after 10 seconds is not necessary to ensure conservative values for peak containment pressures.

NRC Question 4:

Table 4-1 of PUSAR: The peak drywell temperature limit is given as 340°F. Verify by reference to the Updated FSAR (UFSAR) that this limit applies to the containment structure as well as environmental qualification.

PPL Response:

The drywell design temperature of 340°F was specified in the original plant construction specification for the design of civil/structural components (Bechtel Specification 8856-C-110), and is identified in FSAR Section 6.2.1.1.3.1.

NRC Question 5:

PUSAR Section 4.1.2.1: This section states that the NRC approved the use of the detailed Reactor Pressure Vessel (RPV) break flow model in Reference 11. Reference 11 is a GE document. Please clarify.

PPL Response:

Reference 11 is not the correct reference. The correct reference in Section 4.1.2.1 of Attachment 4 (Reference 1) should be "Reference 2" of the PUSAR; "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," (ELTR-1) Topical Report NEDC-32424P-A, Class III (Proprietary), February 1999. The NRC approval is documented with Reference 2.

NRC Question 6:

PUSAR Section 4.1.2.1.2: Explain why the pool swell loads are bounded by the current analysis. Has the pressurization rate decreased? If so, why?

PPL Response:

A postulated LOCA causes an increase in drywell pressure that results in a rapid expulsion of a mixture of non-condensable gases and steam from the drywell through the containment downcomers into the suppression pool. The resulting pool swell compresses the wetwell airspace, which increases the wetwell pressure. This higher pressure acting on the wetwell boundary and the impact, drag and fall back loads on the wetwell components located within the pool swell zone are referred to as pool swell loads. The pool swell load analysis key input parameters are maximum pool surface height, maximum surface velocity, and maximum wetwell (air space) pressure.

The CPPU drywell pressure time history was used as input to the GE Pool Swell Analytical Model (PSAM) to determine the pool surface velocity, acceleration, height, and wetwell pressure response. The PSAM model and the assumptions used to calculate the CPPU pool swell are consistent with the NRC requirements of NUREG-0808, "Mark II Containment Program Load Evaluation and Acceptance Criteria" and NUREG-0487, "Mark II Containment Program Lead Plant Program Load Evaluation and Acceptance Criteria."

The maximum air-bubble pressure occurs at the maximum pool height as stated in NUREG-0808. NUREG-0487 states that the maximum pool height is equal to 1.5 times the initial vent submergence, at which point, bubble "breakthrough" occurs. For SSES, the initial vent submergence is 12 feet, and thus, the pool height at which breakthrough occurs, as accepted in NUREG-0487, is 18 feet (12 ft x 1.5). The maximum CPPU calculated pool height is 18.0 feet, with a corresponding calculated air-bubble pressure of 37.1 psia. The original SSES design analysis conservatively calculated that the maximum pool height would be 18.2 feet, with an air-bubble pressure of 42 psia. Therefore, the maximum air-bubble pressure and pool surface height for CPPU is bounded by original design analysis values.

The increase in wetwell pressure due to CPPU is bounded by the 12% margin between the original design parameter of 56.1 psia and the maximum CPPU calculated accident pressure of 50.1 psia. Therefore, the original plant design basis has sufficient margin in the maximum wetwell pressure value used in the loads analysis to accommodate operation at CPPU conditions.

Up to the point of vent clearing, the CPPU calculated pressurization rate closely matches the current analysis that was performed for the SSES stretch 4.5% power uprate. Both pressurization rates are bounded by a higher pressurization rate calculated for the original plant design. After vent clearing, the pressurization rate of the current analysis (4.5% power uprate) bound the original and CPPU analyses, which will result in the maximum pool surface velocity.

As previously stated, the key input parameters for pool swell load analyses are maximum pool surface height, maximum surface velocity, and maximum wetwell (air space) pressure. Since the CPPU values for these parameters are bounded by the original pool swell analysis or the current analysis, the pool swell loads for CPPU will also be bounded.

NRC Question 7:

PUSAR Section 4.1.2.1.3.2: Explain why design traces selected for small steam line break tests are conservative and why they remain bounding for chugging loads for the CPPU domain.

PPL Response:

In support of the initial commercial licensing of the Susquehanna Units in the late 1970's and early 1980's, PPL utilized Kraftwerk Union (KWU) to conduct a series of steam blow-down tests. KWU was selected because of their extensive experience with quencher design and testing at their GKM-IIM test facility. To evaluate chugging loads, KWU selected four pressure traces associated with a Main Steam Line Break (MSLB). The intensity of the chugs measured in the MSL tests, generally late in time, was significantly larger than in the liquid break tests. Two pressure traces were selected from the Full (1/1) MSL Break Tests, and one pressure trace each were selected from the 1/3 MSL tests and the 1/6 MSL tests. The selected chug pressure-time histories form a conservative and representative database for sourcing the SSES load definition.

Additional conservatism in the SSES original licensed power condition is established by comparing pressure response spectra of the pressure-time histories from GKM-IIM MSL single downcomer vent tests, with similar data from the Japan Atomic Energy Research

Institute (JAERI) multi-vent test program. The latter contains more realistic multi-dimensional effects in the simulation. The results show the considerable conservatism in the GKM-IIM load specification relative to the JAERI test results.

For the SSES 4.5% stretch power uprate, an evaluation concluded that the GKM-IIM MSL tests that were used to select the four chugging pressure time histories were conservative for the 4.5% uprate. This analysis includes a comparison of the SSES Vent Steam Flux history for a full MSL break versus the same parameter for GKM-IIM MSL Tests.

For CPPU, the reactor vessel pressure during normal operation is unchanged. The only significant change is the increased reactor thermal power and modest changes in the water enthalpy distribution within the RPV. Shortly after a MSLB, the reactor will scram. The higher core decay heat and stored thermal energy in solid materials will release slowly and primarily after the blow-down is essentially complete. Thus the MSLB mass flowrate and enthalpy histories are expected to be nearly the same as for the current licensed power for all MSLB cases. The vent steam mass flux histories from GKM-IIM MSL Test conditions bound the SSES full MSLB vent steam mass flux history in the chugging time frame from 35 to 50 seconds.

<u>NRC Question 8</u>:

PUSAR Section 4.1.2.1.5.2: Explain why the maximum air bubble pressures at CPPU conditions are less than the current calculated pressures.

<u>PPL Response</u>:

See the response to Question #6 above.

<u>NRC Question 9</u>:

PUSAR Section 4.1.2.3: (a) explain why the current licensing basis bounds the mass and energy release rates at EPU conditions for the recirculation suction line break and main steam line break, (b) explain why the FWLB at EPU conditions is not bounded by the current licensing basis? (c) provide the current licensing basis and EPU values of the pressure difference across the biological shield, and (d) was a reanalysis done at EPU conditions for the drywell head region subcompartment?

PPL Response:

9 (a)

Since there is no change in dome pressure, the mass and energy released from a MSLB would not change for CPPU.

For the recirculation suction line break (RSLB), the current licensing analysis has a higher mass energy release than CPPU due to higher subcooling in the downcomer region during operation at minimum core flow (MELLLA domain). At CPPU conditions, the dome pressure is unchanged but the increase in CPPU feedwater temperature results in less subcooling in the downcomer region than for the current licensing analysis. Thus, the mass and energy released would be less for a RSLB at CPPU conditions.

9 (b)

For the FWLB, CPPU conditions result in higher mass flow rate and break fluid enthalpy (due to higher feedwater pressure and temperature), which results in a higher mass and energy release profile then the current SSES licensing basis. Thus, the CPPU conditions are not bounded by CLTP conditions.

9 (c)

The analysis performed for the CPPU determines the impact of CPPU on the mass and energy release rates used to perform the annulus pressurization analysis. The analysis does not determine pressure differences across the biological shield wall. Based on the results of the analysis, CPPU will not result in an increase in either RSLB or MSLB mass and energy release rates. As a result, CPPU implementation will not result in an increase in pressure differences across the biological shield wall for either the RSLB or MSLB case.

9 (d)

A reanalysis for the drywell head region subcompartment was not performed for the CPPU.

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]] CPPU implementation should therefore not impact the drywell head region subcompartment pressurization analysis.

NRC Question 10:

PUSAR Section 4.1.6 (GL 96-06): Explain why pipe penetration integrity is unaffected by the CPPU.

PPL Response:

In response to GL 96-06, PPL identified a total of thirteen containment penetrations, which were potentially susceptible to thermally-induced over pressurization during design basis accidents. Of the thirteen, one (a 1" demineralized water line used for maintenance activities) was eliminated through procedural changes. For a second (drywell sump pump discharge), further analysis based on the system and piping configuration concluded that this line was not susceptible to failure. The GL 96-06 disposition for these two penetrations is not affected by CPPU, as the procedures and plant physical configuration remain the same.

For the remaining eleven containment penetrations, PPL performed heat transfer analyses, using accident conditions, to obtain the maximum pressure in the piping associated with each penetration. PPL evaluated the piping and demonstrated that the resulting stresses were within the allowable limits contained in Appendix "F" of the ASME Code. PPL also calculated the pressure capacity of the inboard and outboard valve bodies, and calculated the pressures which would cause leakage through the valve bonnets and discs for each of the eleven penetrations. These calculations indicated that leakage through either the valve disc or valve bonnet gasket would occur at pressures less than the piping or valve body capacity. Therefore, PPL concluded that failure of the pressure boundary of the piping or valve body will not occur at these penetrations. PPL's rationale regarding the potential for thermally induced overpressurization of containment penetrations was reviewed by the NRC, and accepted in Reference 3.

Operation at CPPU conditions will result in a higher pressure and temperature in the containment after a DBA-LOCA. However, the higher CPPU conditions will not affect the calculated leakage pressure through the valve bonnet gaskets and discs for each of these eleven penetrations. Therefore, there are no changes to resolutions for thermally-induced overpressurization that were accepted by the NRC.

NRC Question 11:

PUSAR Section 4.2.6: (a) please provide the peak suppression pool temperatures for the station blackout, anticipated transient without scram, Appendix R fire, and stuck open relief valve events and (b) briefly describe the Appendix R scenario, which results in the peak suppression pool temperature.

PPL Response:

11 (a)

The following table provides the peak suppression pool temperature for the subject scenarios:

Event	Peak Temperature (°F)
Station Blackout	156.6
Anticipated Transient Without Scram	206
Appendix R including stuck open relief valve	191

The limiting Appendix R event includes a stuck open relief valve (SORV). Hence, a separate SORV event was not analyzed.

11 (b)

The limiting Appendix R scenario is a main control room fire with a stuck open safety relief valve and a failure of the RCIC system. Additional SRVs are opened to depressurize the vessel to allow for LPCI injection, which restores reactor vessel inventory. To achieve cold shutdown, the vessel is flooded up to the main steam lines, using LPCI injection through the RHR heat exchanger. This establishes the primary-side return cooling flow path through the main steam SRVs, back to the suppression pool. (Reference PUSAR Section 6.7.1)

NRC Question 12:

PUSAR Section 4.2.6: (a) what is the K value of the residual heat removal heat exchangers, (b) why is this value conservative, and (c) how is assurance provided that the heat exchangers will not have a K value less than this value?

PPL Response:

12 (a)

The K value of the RHR heat exchangers is 317.5 BTU/sec-°F, which is the value assumed in the current licensing basis analysis for containment response.

12 (b)

This value is conservative in that it is based on:

1) 5% tube plugging, which is administratively controlled,
2) a conservative fouling factor, which is based on the water quality of the ultimate heat sink (spray pond), and,
3) ultimate heat sink (spray pond) design temperature of 97°F.

This ultimate heat sink (spray pond) design temperature of 97°F is the maximum post accident spray pond temperature that is not achieved until approximately 40 hours after the start of an event. A more realistic but still conservative value would be the maximum ultimate heat sink (spray pond) temperature allowed by the SSES Technical Specifications (88°F). Peak suppression pool temperature during a design basis LOCA occurs between 8 - 9 hours after event initiation.

12 (c)

The RHR heat exchangers are periodically tested as required by NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety Related Equipment." This testing ensures that the exchangers meet, or exceed their design performance requirement (K value ≥317.5 BTU/sec-°F) with the conditions described in 12 (b) above.

NRC Question 13:

PUSAR Section 4.5: What is the affect of CPPU on the reactor building drawdown time?

PPL Response:

The Secondary Containment drawdown analysis was reviewed for CPPU impact. The design basis parameters modeled in the analysis include SGTS and recirculation fan flows; building volumes, airflow and boundary leakage of the different reactor building ventilation zones; heat loads based on average design temperature within the zones; average pressure for each of the zones; heat up and pressurization due to loss of normal HVAC and transmission heat losses through the walls. CPPU results in a small increase in operating heat load within the zones which contributes very slightly to the heat up and pressurization within the reactor building after loss of normal HVAC systems. This increase is enveloped by the design heat load values used in the analysis. None of the other parameters that affect drawdown time are affected by CPPU. Therefore, a change to the secondary containment drawdown time is not required for CPPU.

Note that the limit for the secondary containment drawdown time was changed as part of the implementation of Alternative Source Term (AST). The revised drawdown time takes advantage of the timing of the AST DBA-LOCA source term and was approved as part of the Unit 1 and 2 License Amendments 239 and 216.

NRC Question 14:

PUSAR Section 4.7: This section states that several assumptions in the combustible gas analysis have been changed, as well as the power level. Please list the significant changes and the justification for these changes.

PPL Response:

There are no significant changes in assumptions or changes in the design or licensing bases for combustible gas.

The specific assumptions cited in PUSAR Section 4.7 are addressed as follows:

a. Degree of Initial mixing between drywell and wetwell atmospheres

   The current licensing basis combustible gas control system (CGCS) evaluation and the CPPU CGCS analysis assume complete mixing within the drywell and wetwell atmospheres individually. There is no mixing between drywell and wetwell atmospheres. This is not a change to the design or licensing bases.

b. Initial gas volume in containment

   This assumption relates to initial gas volume as a percent of overall containment volume. The initial pre-LOCA H_2 concentration is assumed to be the same for CPPU CGCS evaluation as in the current licensing basis. This is consistent with the existing design and licensing bases.

   In addition to calculating recombiner start times based on H2 generation, the CPPU analyses also determined recombiner start times based on O_2 generation as the controlling criteria to ensure flammability limits are not exceeded. The initial pre-LOCA O_2 concentration was not used in the original design basis evaluations. The initial O_2 concentration assumed in the CPPU evaluations is the maximum concentration allowed by Tech Spec and is not a change to the design or licensing bases.

c. Amount of oxygen generation

The original design basis criteria for SSES were focused on maintaining H_2 concentrations to less than 4%. This is consistent with the guidance of Reg. Guide 1.7. As a result, SSES procedures direct initiation of the recombiners based on H_2 concentration and not O_2 concentration.

In addition to calculating recombiner start times based on H2 generation, the CPPU analyses also determined recombiner start times based on O_2 generation as the controlling criteria to ensure flammability limits are not exceeded. The results of the analysis confirmed that H_2 generation remains the controlling criteria under CPPU conditions.

In summary, there were no bases and assumption changes in the analysis that was performed for CPPU that are considered significant nor are there any changes to the design or licensing bases other than the assumed power level.