Britt T. McKinney
Sr. Vice President & Chief Nuclear Officer

PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603
Tel. 570.542.3149 Fax 570.542.1504
btmckinney@pplweb.com

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Washington, DC 20555

SUSQUEHANNA STEAM ELECTRIC STATION
REQUEST FOR ADDITIONAL INFORMATION (RAI) FOR THE REVIEW OF THE SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 AND 2 LICENSE RENEWAL APPLICATION (LRA)
SECTION 4.7.1 **Docket Nos. 50-387**
PLA-6289 **and 50-388**

References: 1) *PLA-6110, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Application for Renewed Operating License Numbers NPF-14 and NPF-22," dated September 13, 2006.*

2) *Letter from Ms. E. H. Gettys, (USNRC) to Mr. B. T. McKinney (PPL), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station, Units 1 and 2, License Renewal Application," dated September 18, 2007.*

In accordance with the requirements of 10 CFR 50, 51, and 54, PPL requested the renewal of the operating licenses for the Susquehanna Steam Electric Station (SSES) Units 1 and 2 in Reference 1.

Reference 2 is a request for additional information related to LRA Section 4.7.1. The enclosure to this letter provides the PPL response to this NRC request.

There are no new regulatory commitments contained herein as a result of this response.

If you have any questions, please contact Mr. Duane L Filchner at (610) 774-7819.

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NRR

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

Executed on: 10 16 07

B. T. McKinney

Enclosure: PPL Response to Request for Additional Information (Section 4.7.1)

Copy: NRC Region I
Ms. E. H. Gettys, NRC Project Manager, License Renewal, Safety
Mr. R. V. Guzman, NRC Sr. Project Manager
Mr. R. Janati, DEP/BRP
Mr. F. W. Jaxheimer, NRC Sr. Resident Inspector
Mr. A. L. Stuyvenberg, NRC Project Manager, License Renewal, Environmental

Enclosure to PLA-6289
PPL Response to
Request for Additional Information
(Section 4.7.1)

NRC RAI 4.7.1-1:

The applicant stated that 40 years of operation would increase steam flow rate by no more than 5 percent, and an additional 20 years of operation could be linearly extrapolated for a total increase in steam flow (and therefore dose) of 7.5 percent.

a. Discuss the basis for assuming an erosion rate of 0.004 inches per year, and if this will be applicable for the term of extended operation. Include whether this is a conservative, realistic, or non-conservative assumption.

b. Provide a copy of a calculation that demonstrates the acceptability of the main steam flow restrictors for the license renewal period. Include descriptions of all relevant parameters and provide the basis and justification for all assumptions.

PPL Response:

Part a

The SSES FSAR Section 5.4.4.4 discusses the potential consequences of an erosion rate "as high as 0.004 inches per year" on the main steam flow restrictor. PPL found no CLB documentation to support a potential erosion rate "as high as 0.004 inches per year." PPL has determined that the rate of 0.004 inches per year is extremely conservative, based on the following discussion.

As stated in EPRI's Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools (EPRI Tools), Revision 4, Section 3.1.6 of Appendix A on treated water: Material loss because of erosion is possible only if the fluid contains particulates in the fluid stream (or water droplets in two phase flow) that impinges upon the surface of the metal. The environment of the main steam lines, at the location of the flow restrictors, is treated water in the form of steam with only 0.1% to 0.2% moisture. Virtually no water droplets exist in the steam in the main steam lines to cause erosion. This is supported by inspection results that have indicated no significant erosion damage in the main steam lines at SSES. Thus, significant erosion of the main steam lines, as well as the flow restrictors, is not plausible due to the lack of a mechanical means for erosion.

Regarding flow-accelerated corrosion (FAC), also referred to as erosion-corrosion, EPRI report TR-106611, "Flow Accelerated Corrosion in Power Plants," Revision 1, states that only carbon steel and steels with low concentrations of chromium, molybdenum, and copper are susceptible to FAC. Table 6-3 of the EPRI report presents a comparison of FAC resistance of several alloys compared to carbon steel. Type 304 stainless steel (18% Cr) is shown as being greater than 250 times more resistant to FAC than carbon

steel. Cast austenitic stainless steel (CASS), ASTM A351 Grade CF8, of which the flow restrictors are constructed, is a stainless steel material with 18% Cr (minimum).

Industry operating experience indicates that loss of material in main steam piping due to erosion and FAC is not significant. In fact, many plants exclude main steam piping from their FAC programs on the basis that FAC does not occur in lines transporting dry steam (reference EPRI Tools, Section 3.1.6 of Appendix A). The SSES operating experience is similar to that of the industry. Inspections of the carbon steel main steam lines at SSES over the life of the plant support the conclusion that significant wear is not occurring due to erosion or FAC. Still, PPL has included the main steam piping in the SSES FAC Program, because the steam in the lines is not 100% dry (superheated). To date, a FAC program inspection of the carbon steel piping immediately downstream of the flow restrictors has been performed on SSES Unit 2. While this piping would be likely to have high wear if FAC conditions were present, the results showed that no significant loss of material had occurred. A wear rate for the main steam line carbon steel piping was calculated by conservatively assuming that any variation in measured wall thickness was due to material loss, rather than original manufacturing deviations. The highest wear rate was determined to be 0.019 inches per year.

In the development of the SSES FAC program, PPL performed a FAC analysis of the main steam piping to determine which locations were most susceptible to FAC. That analysis determined the highest predicted wear rate to be 0.0263 inches per year at an elbow location in the main steam lines. That rate is greater than the 0.019 inches per year determined by the FAC inspection, and it will be assumed as the highest possible wear rate in the carbon steel main steam line. As discussed earlier, a stainless steel component is at least 250 times more resistant to FAC than a carbon steel component. The wear rate for the CASS flow restrictors would then be 0.0263/250, or 0.000105, inches per year. Therefore, the assumed rate of 0.004 inches per year, as discussed in SSES FSAR Section 5.4.4.4, is conservative for the CASS flow restrictors.

As discussed in LRA Section 4.7.1, if erosion of the flow restrictors occurs, the eventual increase in the throat area of the venturi section of the flow restrictor would result in decreased flow velocity. Any decrease in the flow velocity would reduce the rate of erosion or FAC to less than 0.004 inches per year. Therefore, the assumed maximum wear rate of 0.004 inches per year remains conservative for the period of extended operation.

Part b

As discussed in LRA Section 4.7.1, the TLAA concerning the performance of the main steam line flow restrictors was projected to the end of the period of extended operation. While the statements in the SSES FSAR Section 5.4.4.4 implied a TLAA, there was no existing design calculation or analysis identified for this TLAA. Because there is no

documented calculation to provide to the NRC, the demonstration of the acceptability of the flow restrictors for the license renewal period of extended operation is presented here.

As discussed in Part a to this RAI, an erosion rate of 0.004 inches per year is a conservative assumption. Thus, over 60 years, the throat diameter of the venturi section of the flow restrictor is conservatively estimated to increase by 0.480 inches (0.004 x 2 x 60). Because the flow restrictor had an original throat diameter of 12.580 inches, the diameter would be 13.060 inches (12.580 + 0.480) after 60 years. This would increase the throat area of the flow restrictor by 7.8%, and, because the flow is proportional to the throat area, the flow through the restrictor following a main steam line break would also increase by 7.8%. This is a conservative value for the flow increase, because the assumed erosion rate is conservative.

The design safety function of the flow restrictors is to limit the radiological release outside of the drywell following a main steam line break and prior to MSIV closure. PPL has performed an evaluation of the Control Room Habitability Envelope (CRHE) and offsite radiological doses at the exclusion area boundary and the low population zone following a main steam line break outside of containment using the Alternative Source Term (AST) methodology described in NRC Regulatory Guide 1.183. The mass release from the steam line break was assumed to be 117,654 lbm, representing a 20% increase to the original licensing value of 97,970 lbm. The 20% increase provided additional margin for the extended power uprate, which was unnecessary, because it is now documented that the mass release following a main steam line break will not increase. (SSES PUSAR submittal, PLA-6076). The highest ratio of any calculated dose to its acceptance criteria is 18.6%. Thus, even with a 20% flow increase, there is still a safety margin of at least 81.4% on the doses. Therefore, an increase of 7.8% in the mass release from a postulated steam line break is acceptable because it is enveloped by the 20% increase considered in the evaluation.