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SUSQUEHANNA STEAM ELECTRIC STATION
REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 AND 2, LICENSE RENEWAL APPLICATION (LRA) SECTION 3.3.2.2.6
PLA-6504

Docket Nos. 50-387 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. W. H. Spence (PPL), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station, Units 1 and 2 License Renewal Application," dated April 13, 2009.*

3) *EPRI Technical Report, "Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications," November 2006 edition.*

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 (RAI) related to License Renewal Application (LRA) Section 3.3.2.2.6. The enclosure to this letter provides the question responses and the additional requested information.

There is one new regulatory commitment contained herein. Commitment #61, regarding Boral coupon testing, is added to LRA Table A-1.

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

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URR

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

Executed on: 5-13-09

Richard D Pagodin for W H Spence
W. H. Spence

Enclosure: PPL Response to NRC's Request for Additional Information (RAI)

Copy: NRC Region I
Ms. E. H. Gettys, NRC Project Manager, License Renewal, Safety
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-6504
PPL Response to NRC's
Request for Additional Information (RAI)

RAI 3.3.2.2.6-2:

In the RAI response dated August 15, 2008, on page 28/49 there is mention of decay products. Please describe these decay products.

PPL Response:

The decay products mentioned in response to RAI 3.3-1 should more appropriately have been described as corrosion products. Some of the Susquehanna Boral test coupons are vented, exposing the Boral to spent fuel pool water. Oxidation of the aluminum constituent in these test coupons occurs. The corrosion products resulting from oxidation of the aluminum are what were referred to as "decay products" in the referenced RAI response.

RAI 3.3.2.2.6-3:

In the RAI response dated August 15, 2008, on page 29/49 there is a table titled, "SSES Spent Fuel Pool Boral Average B-10 Areal Density Results." From this table, the staff has the following questions:

a. How many coupons are left in each pool? Please discuss the schedule for coupon removal and testing during Susquehanna's period of extended operation to demonstrate continued Boral performance.

b. How can the projected value at year 2015 for the Unit 2 areal density result be higher than any value actually measured during the first 30 years of service?

PPL Response:

a. Three sets of coupons remain in the Unit 1 spent fuel pool, and three sets of coupons remain in the Unit 2 spent fuel pool. The test coupons consist of sets of vented and unvented cans connected together in single assemblies. The unvented cans represent the sealed and pressure tested poison cans used in the spent fuel pool racks and the vented cans are used to demonstrate the effects of a leak in a poison can on the Boral material.

   The schedule for coupon removal and testing does not currently extend into the period of extended operation. A new license renewal commitment is added to continue coupon testing during the period of extended operation, with removal and testing of one set of coupons during the tenth or eleventh year after Unit 1 enters the period of extended operation. The plant is operated with the Unit 1 and Unit 2 spent fuel pools cross-tied. Therefore testing a single set of coupons will provide results representative of both

pools. Because degradation of the neutron absorbing capability is not expected and there has been no operating experience to date identifying loss of neutron absorbing capability, a single test approximately half way through the period of extended operation will be adequate. Comparison of these test results with results obtained prior to year 40 along with continued monitoring of industry operating experience will provide adequate assurance that any age-related degradation of the Boral will be detected.

LRA Table A-1 is revised to include new license renewal commitment #61 to continue the Boral coupon testing in the period of extended operation.

Table A-1 SSES License Renewal Commitments

➢ LRA Table A-1 (LRA page A-55) is revised by addition (***bold italics***) as follows:

Table A-1
SSES License Renewal Commitments

Item Number	Commitment	FSAR Supplement Location (LRA App. A)	Enhancement or Implementation Schedule
61) Boral Coupon Testing	***Spent fuel pool Boral coupon testing will be continued in the period of extended operation with one set of coupons being tested during the tenth or eleventh year after Unit 1 enters the period of extended operation.***	----------	***Ongoing***

b. The projected areal density for the Unit 2 spent fuel pool Boral at year 2015 is based on linear regression modeling of the measured values to date. The linear regression is performed to trend the test data to predict whether or not the areal density will reach minimum allowable levels prior to the next scheduled coupon removal and test. The best fit curve from the linear regression results in a projection that is slightly higher than values measured to date. Overall, the measured data trend shows no significant degradation is expected by 2015.

RAI 3.3.2.2.6-4:

In the RAI response dated July 24, 2008, it states that, "SSES does not monitor for nor have plant-specific operating experience regarding the presence of aluminum cations in the spent fuel pool." Please explain why SSES does not monitor for aluminum cations when there is industry operating experience of aluminum dissolving from Boral panels in spent fuel pools. Also, please describe how the Water Chemistry Program monitors for and mitigates the loss of neutron absorbing material in the spent fuel pool.

PPL Response:

SSES does not currently monitor the spent fuel pool water for the presence of aluminum cations. Based on the design of the SSES fuel storage racks, industry and SSES operating experience to date, and the operation of the Fuel Pool Cooling and Cleanup System, we have concluded that addition of monitoring for aluminum cations is not essential to effective aging management of the Boral neutron absorbers in the spent fuel storage racks.

The design of the fuel storage racks at SSES utilizes Boral panels that are sealed in aluminum cans such that the Boral is not expected to be exposed to spent fuel pool water. Therefore, the mechanism described in the RAI for introduction of aluminum into the water from corrosion of the Boral panels is not expected to occur.

The EPRI Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications, November 2006 Edition, (referred hereafter as Reference 3 or technical report), provides a summary of industry Boral surveillance coupon test results. As discussed in the technical report, some corrosion of the aluminum in the Boral sheets is expected to occur if the Boral is exposed to the fuel pool water. However, the technical report notes that even the most severe surveillance coupon corrosion observed to date has not resulted in any decrease in boron-10 areal density. The SSES test coupons include vented samples that expose the Boral to fuel pool water to simulate a failed poison can weld. The twenty-year coupon surveillances performed at SSES identified some corrosion of coupons exposed to fuel pool water, but concluded that corrosion is a condition of appearance only that in no way affected the function of the material. Therefore, based on industry and SSES operating experience, some corrosion of the aluminum constituent of Boral is expected if exposed to fuel pool water, but no impact is expected on the neutron-absorbing function.

The Fuel Pool Cooling and Cleanup System includes filter demineralizers, which remove aluminum and other metals from the water. If aluminum is present in the fuel pool water, it would be removed by constant processing of the fuel pool water through the filter demineralizers. Therefore, monitoring for aluminum concentrations would not provide meaningful information about the presence of Boral corrosion.

Susquehanna does not monitor for aluminum cations in the spent fuel pool, because:

- The design of the SSES fuel storage racks prevents exposure of the Boral to fuel pool water, thereby precluding generation of aluminum cations from this source.
- The filter demineralizers continuously remove aluminum from the fuel pool water such that monitoring for aluminum concentrations would not provide information that can be used as an indicator of Boral corrosion.
- Corrosion of Boral exposed to fuel pool water is expected and has not been shown to affect the design function of the Boral. Water chemistry controls to mitigate the loss of material due to corrosion, along with continued coupon testing and monitoring of industry operating experience provide reasonable assurance that the Boral will continue to perform its design function during the period of extended operation. Therefore, additional measures to determine if corrosion is occurring, such as monitoring for aluminum cations, are not warranted.

The BWR Water Chemistry Program is credited with aging management of the aluminum constituent in the Boral sheets used in the spent fuel storage racks. The BWR Water Chemistry Program does not monitor for the loss of neutron absorbing material. The program monitors and controls water chemistry parameters within limits to mitigate loss of material due to crevice or pitting corrosion in case any of the poison cans should develop a leak and the Boral becomes exposed to the fuel pool water. The Boral coupon testing, which will be continued into the period of extended operation in accordance with new license renewal commitment #61, serves to verify the effectiveness of the BWR Water Chemistry Program.

RAI 3.3.2.2.6-5:

In September 2003, inspection of Boral test coupons at Seabrook Nuclear Station revealed bulging and blistering of the aluminum cladding. Please discuss the impact, if any, that this event is considered to have on the surveillance of Boral at Susquehanna. Industry experience has indicated that during long term exposure such blisters may form. Also, in the RAI responses, it states, "These vented samples have shown blistering near the edges of the plate due to the porous nature of the cut edge of the plate, where water interacts with the Boron matrix and radiation to generate gases that blister the plate. This effect has, in some cases, caused the outer metal layer of the Boral plate (sample) to blister out and press flat against the outer tube that contains it." Since formation of blisters may affect the efficiency of the Boral panels to attenuate neutrons (through flux trap formation) and may cause deformation of the fuel storage cells, the applicant should explain why blistering of the Boral panels will not be a safety concern in its plant.

PPL Response:

The Seabrook operating experience in 2003 identified blistering and bulging of the aluminum cladding of Boral test coupons. The Seabrook experience raised questions about the potential impact of blistering on the neutron attenuation properties of the Boral and the potential impact on spent fuel pool criticality analyses. A summary of industry Boral surveillance coupon test results is provided in Reference 3. This technical report discusses the effects of blistering of Boral cladding and concludes that, to date, the neutron absorption properties of the Boral have not been affected by formation of blisters. Testing of Boral coupons at Susquehanna has continued and although some blistering of the aluminum cladding has been observed on vented test coupons, evaluations have shown that the boron areal density remains within specification. Blistering of the aluminum cladding is not a concern for the SSES spent fuel criticality analysis as described below.

As described previously, the Susquehanna Boral panels are sealed in aluminum cans and are not expected to be exposed to spent fuel pool water. The test coupons consist of sets of vented and unvented cans. The unvented cans represent the sealed and pressure tested poison cans used in the spent fuel pool racks and the vented cans are used to demonstrate the effects of a leak in a poison can on the Boral material. The unvented coupons have never shown any signs of blistering or any other defects. The unvented coupons have always been found in the as-fabricated condition with the surface appearing as mill finish Boral. The vented coupons have shown signs of surface blistering, but the blisters (where aluminum clad delaminates from core) are only conditions of appearance and have not had any affect on the Boral neutron absorbing capability. The blisters are located near the cut edges of the Boral coupons. No loss of core material has been observed and neutron attenuation and areal density test results have always exceeded minimum specifications, demonstrating that the blisters do not impact the design function of the Boral.

PWR Region 1 flux trap design racks incorporate the neutron attenuating properties of water (flux trap) into the design. In this rack design, formation of Boral blisters could deform the thin gauge wrapper plate and displace water in the flux trap region, reducing the effect of the water gap flux trap, and resulting in an increase in the reactivity in the racks. Reference 3 discusses this potential effect of Boral blistering and concludes it affects Region 1 PWR fuel racks only. Since the Susquehanna racks do not use the flux trap design, this effect of Boral blistering is not a concern.

Reference 3 discusses Boral blistering and states that blisters in the Boral occurring under the thin gauge wrapper plate of BWR or PWR Region 2 type racks could cause the wrapper plate to deform, thereby reducing the free clearance in the fuel storage cell. As described in Reference 3, this thin gauge wrapper is 0.020" thick and forms the walls of some of the fuel storage cells. The Susquehanna fuel racks are of a different design than that described in the technical report. The Susquehanna Boral sheets are sandwiched between two aluminum tubes, each 0.125" thick, which are welded together to provide a

sealed poison can. These aluminum tubes form the walls of the fuel storage cells. While fuel cell wall deformation due to Boral blister formation has been shown to occur in rack designs with much thinner poison can walls, this condition is not expected to occur in the Susquehanna racks. The coupon surveillance program supports this conclusion. The test coupon cans are of the same construction (except shorter) as the poison cans used in the racks. No bulging of the Susquehanna test coupon can walls has been observed even with the blistering that has been noted on the Boral test coupons from vented cans.

Based on the preceding discussion, blistering of the Boral used in the spent fuel storage racks is not a safety concern for Susquehanna. Continued inspection and testing of the Boral test coupons will provide further assurance that any degradation of the Boral that could impact plant safety will be detected.

Note: During the Unit 2 14th refueling outage in May 2009, SSES identified a bulging condition on the inner aluminum wall of one fuel storage cell. This new SSES OE does not alter the conclusion that blistering of the Boral is not a safety concern for SSES. Refer to the response to RAI 3.3.2.2.6-6 for the discussion on this new OE.

RAI 3.3.2.2.6-6:

Please discuss any other operating experience that may be applicable to Susquehanna and describe why it would not be a safety concern.

PPL Response:

In September 2008, an attempt to remove an irradiated fuel assembly from storage cell location PP-2 in the SSES Unit 1 Spent Fuel Storage Pool (SFSP) was unsuccessful. That particular fuel assembly currently remains in cell PP-2, and the surrounding/adjacent cells currently do not have fuel stored in them. Visual inspections of the surrounding cells have not identified any poison can deformation or the presence of any foreign material causing interference with the assembly. PPL has not determined the cause of this condition in the PP-2 storage cell at this time.

As a result of the issue with the assembly in the PP-2 Unit 1 SFSP cell, and a previous incident in March 2006 in which a blade guide could not be inserted into the Unit 1 SFSP cell C-13, a visual inspection of cell C-13 was performed during the recent Unit 2 14th refueling and inspection outage (U2-14RIO) in May 2009. Significant bulging of one of the four poison can walls was observed. The cell is currently empty and will not be used for storage. Cell C-13 and the surrounding adjacent cells historically have been reserved for storage of non-fuel components (e.g., blade guides) and are not used to store spent fuel assemblies. The condition of cell C-13 has been entered into the SSES Corrective Action Program for evaluation and determination of necessary follow-up activities. Although the cause of the deformation in cell C-13 has not yet been determined, industry

operating experience suggests it may be the result of hydrogen gas generation from either moisture contained in the Boral at the time of manufacture or a leaking seal weld in the poison can.

The Susquehanna SFSPs contain over 5000 locations where spent fuel assemblies are typically stored. During fuel handling activities over the past few years, and in particular, during the most recent fuel movements prior to and during the U2-14RIO, no other significant interference issues have been encountered, nor have there been any other similar observations of rack deformation. This suggests the issues related to cells PP-2 and C-13 are isolated incidents and are not indicative of a widespread fuel storage rack problem. Further evaluations and follow-up actions are being conducted via the SSES Corrective Action Program. Based on the evaluations that have been performed to-date and past industry experience, PPL finds that there is no current safety concern with the Susquehanna SFSPs.

In addition to the recent SSES operating experience, Reference 3 includes a summary of in-service experience with Boral. The two primary issues identified in the summary of operating experience are loss of material due to corrosion and blistering of the aluminum cladding of the Boral sheets. As discussed in response to the preceding RAIs, these issues are not safety concerns for Susquehanna. Neither corrosion or blistering has resulted in loss of neutron absorbing capability of the Boral material at Susquehanna, and Reference 3 reaches a similar conclusion based on the operating experience reported in that document. PPL is not aware of any other operating experience that is applicable to Susquehanna.