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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) SECTIONS B.2.41, B.2.42, B.2.43, B.3.2, AND 3.6
PLA-6398

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. 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 July 3, 2008.*

3) *PLA-6362, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Susquehanna Steam Electric Station Units 1 and 2 License Renewal Application (LRA) Station Blackout Scope Addition," dated May 7, 2008.*

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 contains three (3) Aging Management Program (AMP) Generic Electrical Questions in addition to a request for additional information (RAI) related to License Renewal Application (LRA) Sections B.2.41, B.2.42, B.2.43, B.3.2, and 3.6. The enclosure to this letter provides the question responses and the additional requested information.

There are no new regulatory commitments contained herein as a result of the attached responses.

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: 8/5/08

B. T. McKinney

Enclosure: PPL Responses to NRC's Generic Electrical Questions and 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-6398
PPL Responses to NRC's
Generic Electrical Questions
and
Request for Additional Information (RAI)

Aging Management Programs (AMPs) Generic Electrical Questions

NRC Question 1:

Under the "operating experience" program element in the license renewal application (LRA), the applicant states that the aging management program (AMP) B.2.41, B.2.42, B.2.43, B.2.44, and B.2.45 are new programs for which there is no Susquehanna Steam electric Station (SSES) specific operating experience. However, staff noticed some operating experiences while performing the audit on site.

a. Provide a summary of the plant specific operating that is experience relating to each AMP.

b. Explain how the AMP will be effective in managing the aging degradation from the plant specific operating experience described above.

PPL Response:

The response to this NRC Generic Electrical Question is organized by AMP, with both parts "a" and "b" being addressed under each AMP.

AMP B.2.41, "Non-EQ Electrical Cable and Connections Visual Inspection Program"

This license renewal AMP has not yet been implemented, but following are examples of Susquehanna operating experience that demonstrate that the aging effects of interest in this AMP (i.e., degradation of cable insulation in adverse localized environments), can be, and have been, successfully detected at SSES.

- During routine preventive maintenance activities in 2000, cables connected to moisture separator level switches were found to be brittle and cracked due to excessive heat. The damaged cables were replaced.

- In 2002, instrumentation cables connected to a thermocouple in the main steam tunnel were found to be heat damaged and brittle. The damaged section of cable was replaced.

The fact that these aging effects have been detected at SSES and corrective action was taken, supports the conclusion stated in the SSES LRA, that this AMP, "...will provide reasonable assurance that the aging effects will be managed such that the non-EQ cables and connections subject to aging management review will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation."

AMP B.2.42, "Non-EQ Electrical Cable and Connections used in Low-Current Instrumentation Circuits Program"

This license renewal AMP has not yet been implemented, but the following example of Susquehanna operating experience demonstrates that the aging effect of interest in this AMP (i.e. reduction in insulation resistance), can be, and has been, successfully detected at SSES.

- During routine plant maintenance activities in 2003, two Unit 2 local power range monitoring cables were identified with lower than acceptable insulation resistance. The cables were replaced.

The fact that this aging effect has been detected at SSES and corrective action was taken, supports the conclusion stated in the SSES LRA, that this AMP, "...will provide reasonable assurance that the aging effects will be managed such that the non-EQ cables and connections used in sensitive, high-voltage, low-current circuits, that are subject to aging management review, will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation."

AMP B.2.43, "Non-EQ Electrical Inaccessible Medium-Voltage Cable Program"

This license renewal AMP has not yet been implemented, but the following example of Susquehanna operating experience that demonstrates that the aging effect of interest in this AMP (i.e. degradation of the conductor insulation for medium voltage cables exposed to significant moisture and voltage), can be, and has been, successfully detected at SSES.

- A negative trend in power factor test results of 15 kV underground cables supplying power to the plant's river water intake was detected. These cables are continuously energized and known to be wet. The test results are indicative of expected aging of the cable insulation system. These cables continue to be monitored under the plant corrective action program.

The fact that this aging effect has been detected at SSES and is being monitored, supports the conclusion stated in the SSES LRA, that this AMP, "...will provide reasonable assurance that the aging effects will be managed such that the inaccessible, non-EQ medium-voltage cables subject to aging management review will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation."

AMP B.2.44, "Metal-Enclosed Bus Inspection Program"

This license renewal AMP has not yet been implemented, but inspections of metal enclosed bus have been performed. Visual inspections were performed of bus 0A206 in

2006 and 0A107 in 1996. No significant age-related degradation was detected during these inspections. The bus enclosures were found to be clean, with no evidence of overheating of bus connections. These activities have demonstrated that the bus is generally accessible for visual inspection and in good condition, such that if any aging effects of interest for this AMP do occur, they should be detected during future inspections.

AMP B.2.45, "Non-EQ Electrical Cable Connections Program"

This license renewal AMP has not yet been implemented, but following are examples of Susquehanna operating experience that demonstrate that the aging effects of interest in this AMP (i.e., loosening of cable connections), can be, and have been, successfully detected at SSES.

- During routine maintenance activities in 2007, a cable crimp connection in a switchgear cubicle was found to be operating at a higher temperature than other connections in the same circuit. The temperature differential was only minor, and determined not to be an operability concern; however, the cable lug was replaced. This demonstrates that loose connections can be detected via thermography before loss of intended function.

- In 1997, while performing preventive maintenance activities on a battery charger, a hot spot was detected on the DC output cable lugs using thermography. The cable lugs were replaced and the battery charger was returned to service without loss of intended function.

The fact that these aging effects have been detected at SSES and corrective action was taken, supports the conclusion stated in the SSES LRA, that this AMP, "...will provide reasonable assurance that the aging effects will be managed such that the non-EQ electrical cable connections subject to aging management review will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation."

NRC Question 2:

The Standard Review Plan for Review of License Renewal (SRP-LR), Table 3.6-2 "FSAR Supplement for Aging Management of Electrical and Instrumentation and Control System" identifies when the inspection will be implemented and how often the inspection will be performed. Susquehanna Final Safety Analysis Report (FSAR) supplement for AMP B.2.41, B.2.42, B.2.43, B.2.44, and B.2.45 do not provide the frequency of inspection. Provide the inspection frequency for each AMP in the FSAR.

PPL Response:

The FSAR supplement under LRA Section A.1.2, Aging Management Program and Activities, is revised as follows to provide the inspection frequency for each of the listed electrical AMPs.

A.1.2 Aging Management Program and Activities

- The FSAR supplement associated with AMP B.2.41, LRA Section A.1.2.35 (on LRA page A-16) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

A.1.2.35 Non-EQ Electrical Cables and Connections Visual Inspection Program

The Non-EQ Electrical Cables and Connections Visual Inspection Program manages the aging of non-EQ electrical cables and connections within the scope of license renewal. The program provides for ~~the periodic~~ visual inspection ***on a 10-year interval,*** of accessible, non-EQ electrical cables and connections, in order to determine if age-related degradation is occurring, particularly in plant areas with high temperatures and/or high radiation levels.

The Non-EQ Electrical Cables and Connections Visual Inspection Program is a new aging management program that will be implemented prior to the period of extended operation.

- The FSAR supplement associated with AMP B.2.42, LRA Section A.1.2.34 (on LRA page A-16) is revised by addition (***bold italics)***.

A.1.2.34 Non-EQ Cables and Connections Used in Low-Current Instrumentation Circuits Program

The Non-EQ Cables and Connections Used in Low-Current Instrumentation Circuits Program manages the age-related degradation associated with non-EQ, low-current instrumentation cables and connections within the scope of license renewal. The program applies to in-scope, non-EQ electrical cables and connections used in neutron monitoring and radiation monitoring circuits with sensitive, low-current signals.

The Non-EQ Cables and Connections Used in Low-Current Instrumentation Circuits Program will perform testing of the applicable cable systems to identify reduction in insulation resistance. ***The tests will be performed at least every ten years, with the frequency to be determined by engineering evaluation.***

The Non-EQ Cables and Connections Used in Low-Current Instrumentation Circuits Program is a new aging management program that will be implemented prior to the period of extended operation.

- The FSAR supplement associated with AMP B.2.43, LRA Section A.1.2.36 (on LRA page A-17) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

A.1.2.36 Non-EQ Inaccessible Medium-Voltage Cables Program

The Non-EQ Inaccessible Medium-Voltage Cables Program manages the aging of non-EQ inaccessible medium-voltage electrical cables subject to wetting within the scope of license renewal. The program provides for ~~the periodic~~ testing of non-EQ inaccessible medium-voltage electrical cables, in order to determine if age-related degradation is occurring, and includes provision for the inspection of associated manholes to identify any collection of water. ***The cable testing frequency will be based on plant operating experience, but will be performed at least once every ten years. The electrical manhole inspection frequency will be based on plant operating experience, but will be performed at least once every two years.***

The Non-EQ Inaccessible Medium-Voltage Cables Program is a new aging management program that will be implemented prior to the period of extended operation.

- The FSAR supplement associated with AMP B.2.44, LRA Section A.1.2.32 (on LRA pages A-15 and A-16) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

A.1.2.32 Metal-Enclosed Bus Inspection Program

The Metal-Enclosed Bus Inspection Program manages the aging of the metal-enclosed bus within the scope of license renewal. The program provides for ~~the periodic~~ inspection of the applicable metal-enclosed bus ***on a 10-year interval***, in order to determine if age-related degradation is occurring.

The Metal-Enclosed Bus Inspection Program is a new aging management program that will be implemented prior to the period of extended operation.

- The FSAR supplement associated with AMP B.2.45, LRA Section A.1.2.37 (on LRA pages A-17) is revised by addition (***bold italics)***.

A.1.2.37 Non-EQ Electrical Cable Connections Program

The Non-EQ Electrical Cable Connections Program manages the aging for the metallic parts of non-EQ electrical cable connections within the scope of license renewal. The program addresses cable connections that are used to connect cable conductors to other cables or electrical devices. Aging management for the metallic parts of the non-EQ electrical cable connections that are subject to aging stressors will be provided by testing. A representative sample of non-EQ electrical cable connections will be selected

for testing, considering the effects of their application (high, medium, and low voltage), circuit loading, and location with respect to electrical connection stressors. Thermography will be used to test a representative sample of cable connections to provide an indication of the integrity of the connections. ***The tests will be performed at least every ten years, with the frequency to be determined by engineering evaluation.***

The Non-EQ Electrical Cable Connections Program is a new aging management program that will be implemented prior to the period of extended operation.

NRC Question 3:

In the LRA, the applicant states that the AMPs are consistent with the generic aging lessons learned (GALL) Report and referred to a corrective action element in LRA, Section B.1.3, that is common to all SSES AMPs. The corrective actions described in Section B.1.3 do not contain certain requirements as described in the GALL AMP XI.E1, E2, E3, E4, and E6. Explain in detail how the generic corrective actions in Section B.1.3 are consistent with those in the GALL AMPs.

PPL Response:

The discussion of corrective action in Section B.1.3 of the LRA is a summary evaluation of the SSES corrective action process, which satisfies 10 CFR 50, Appendix B, and is judged effective as related to the activities of all aging management programs at SSES.

For the electrical programs (GALL XI.E1, XI.E2, XI.E3, XI.E4, and XI.E6), the specific details related to corrective actions for each program are outlined below.

- For XI.E1 (LRA AMP B.2.41), all unacceptable visual indications of cable and connection jacket surface anomalies are subject to an engineering evaluation. The evaluation will consider the age and operating experience of the component, as well as the severity of the anomaly and whether the anomaly has previously been correlated to degradation of the conductor insulation or connections. Corrective actions may include, but are not limited to, testing, shielding or otherwise changing the environment, or relocation/replacement of the affected cable or connection. When an unacceptable condition or situation is identified, a determination will be made as to whether the same condition or situation is applicable to other in-scope cables or connections.
- For XI.E2 (LRA AMP B.2.42), corrective action such as recalibration and circuit trouble-shooting are implemented when calibration or surveillance results do not meet the acceptance criteria. An engineering evaluation is performed when the test results do not meet the acceptance criteria. The evaluation will consider the significance of the test results, the operability of the component, the reportability

of the event, the extent of the concern, the potential root causes, the corrective actions required, and the likelihood of recurrence.

- For XI.E3 (LRA AMP B.2.43), an engineering evaluation is performed when the test acceptance criteria are not met in order to ensure that the intended functions of the electrical cables can be maintained consistent with the current licensing basis. The evaluation will consider the significance of the test results, the operability of the component, the reportability of the event, the extent of the concern, the potential root causes, the corrective actions required, and the likelihood of recurrence. When an unacceptable condition or situation is identified, a determination will be made as to whether the same condition or situation is applicable to other in-scope medium-voltage cables.
- For XI.E4 (LRA AMP B.2.44), further investigation and evaluation are performed when the acceptance criteria are not met. Corrective actions may include (but are not limited to) cleaning, drying, an increased inspection frequency, replacement, or repair of the affected metal-enclosed bus (MEB) components. If an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other MEBs.
- For XI.E6 (LRA AMP B.2.45), an engineering evaluation is performed when the test acceptance criteria are not met to ensure that the intended functions of the cable connections can be maintained consistent with the current licensing basis. The evaluation will consider the significance of the test results, the operability of the component, the reportability of the event, the extent of the concern, the potential root causes, the corrective actions required, and the likelihood of recurrence. When an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other in-scope cable connections that were not tested.

Requests for Additional Information (RAI)

RAI B.2.41-1

The GALL Report AMP XI.E1 considers the technical information and guidance provided in NUREG/CR-5643, IEEE Std. P1205, SAND 96-0344, and EPRI TR-109619. In the LRA B.2.41, the applicant states that this program is consistent with GALL. However, the applicant did not provide technical information and guidance as reference in the GALL Report AMP XI.E1. Provide specific technical/industrial guidance for which will be used to develop this AMP.

PPL Response:

The technical documents listed in GALL AMP XI.E1 (NUREG/CR-5643, IEEE Standard P1205, SAND96-0344, and EPRI TR-109619) provide information pertinent to plant environmental conditions, environmental effects (particularly with regard to adverse environmental conditions), evaluation of environmental conditions and effects, degradation mechanisms, and aging effects. The information is relevant to the understanding of electrical cable aging mechanisms and effects, and is also relevant to potential inspection methods to identify degradation. The technical guidance contained in these NRC and industry reports will be used as input to develop this AMP.

RAI-B.2.41-2

The GALL Report AMP XI.E1 states that "[a]n adverse localized environment is a condition in a limited plant area that is significantly more severe than the specified service environment for the cable." Explain in detail how an adverse localized environment, with the most limiting service environment such as, radiation, temperature, and moisture is determined.

PPL Response:

Adverse localized environments are identified by using a combination of existing information and plant walk downs. An adverse localized environment typically occurs when cables are routed in proximity to a source of heat or radiation, or are exposed to significant moisture. Information sources that can be used to identify potential adverse localized environments include:

- Plant design information – Design drawings, calculations and databases identify hot process pipes, radiation sources, and cables routed through areas with the potential for the existence of significant moisture.
- Experience and knowledge of plant personnel - Interviews of plant maintenance, operations, radiological protection, and engineering personnel can be used to

identify areas where cables may be exposed to elevated temperatures, radiation, or significant moisture.

- Radiological survey maps – Routine radiological surveys identify radiation sources.
- Plant operating experience records - Searches of the corrective action system database identify areas where cable degradation has occurred.

Plant walk downs guided by the information from these sources, along with the use of thermography to identify heat sources, will determine the adverse localized environments.

RAI B.2.42-1

The GALL Report AMP XI.E2 recommends the technical information and guidance provided in NUREG/CR-5643, IEEE Std. P1205, SAND 96-0344 and EPRI TR-109619. In the LRA AMP B.2.42, the applicant states that its program will be consistent with the GALL Report and yet it did not provide any information on industrial technical guidance. Provide specific technical guidance which will be used to develop this new AMP.

PPL Response:

The technical documents listed in GALL AMP XI.E2 (NUREG/CR-5643, IEEE Standard P1205, SAND96-0344, and EPRI TR-109619) provide information pertinent to plant environmental conditions, environmental effects (particularly with regard to adverse environmental conditions), evaluation of environmental conditions and effects, degradation mechanisms, and aging effects. The information is relevant to the understanding of electrical cable aging mechanisms and effects, and is also relevant to potential inspection methods to identify degradation. The technical guidance contained in these NRC and industry reports will be used as input to develop this AMP.

RAI B.2.42-2

The GALL Report AMP XI.E2 states that a proven cable system test for detecting deterioration of the insulation system (such as insulation resistance tests, time domain reflectometry tests, or other testing judged to be effective in determining cable insulation condition as justified in the application) will be performed. In AMP B.2.42, under the same element, the applicant stated that the testing methodology will be specified prior to the first test. Provide the type of tests that will be used to detect degradation of insulation in high voltage, and low level signal instrumentation circuits.

PPL Response:

The LRA states that this is a new program that will be implemented consistent with GALL. Therefore, as recommended in GALL, a proven cable system test for detecting

degradation of insulation such as, insulation resistance testing, time domain reflectometry, or other suitable test, will be used. The test method will be selected prior to performance of the first test and will be a test type consistent with the recommendations of GALL.

RAI B.2.43-1:

In the LRA AMP B.2.43, under the "scope of program" element, it states that this program applies to six cables associated with the offsite power supply for SSES and that these are the only inaccessible medium-voltage cables at SSES that are within the scope of license renewal and are exposed to significant moisture and significant voltage. The staff noted that the residual heat removal and emergency service water pump cables could be subjected to significant moisture. Explain why these cables are not in-scope of B.2.43.

PPL Response:

The cables for the residual heat removal (RHR) pump motors are not in the scope of the B.2.43 AMP because they are not routed underground and are not exposed to significant moisture. The cables for the RHR service water (RHRSW) and emergency service water (ESW) pump motors are not included in the scope of the B.2.43 AMP because they are energized less than 25% of the time. As described in NUREG-1801 XI.E3, this AMP applies to inaccessible medium-voltage cables within the scope of license renewal that are exposed to significant moisture simultaneously with significant voltage. Significant moisture is defined as periodic exposures to moisture that last more than a few days, and significant voltage is defined as being subject to system voltage more than 25% of the time. Therefore, because the RHR, RHRSW, and ESW pump motor cables are either not exposed to significant moisture, or to significant voltage, they are excluded from the scope of AMP B.2.43.

RAI B.2.43-2:

The staff reviewed operating experience and noted that inaccessible medium-voltage cables in certain manholes at SSES have experienced significant moisture (cable in standing water for more than few days). In addition, during a walk down, the staff found several feet of water in Manholes Number 2 and 16.

a. Identify manholes that have experienced significant water. Identify specific circuits in those manholes that have significant water. Are these cable qualified for submergence? If they are, provide manufacturer qualification for these cables.

b. Provide a basis as to how performing cable test every 10 years is adequate to detect aging effects given the plant's field operating experience.

c. How is inspection frequency adjusted based on field operating experience?

d. What corrective actions have been taken or planned to address significant moisture conditions in these manholes?

PPL Response:

a. The manholes that have experienced significant water (i.e. medium voltage cables within the scope of license renewal in standing water for more than a few days) are MH001, MH002, MH007, MH008, and MH009. The in-scope medium voltage circuits in these manholes are the 13.8kV circuits associated with the offsite power supplies that connect the startup transformers to the startup buses (cable numbers NH0A0351A-T and NH0A0352A-T).

   The term "submergence" is not used in any of the cable technical specifications, manufacturer's documentation, or industry standards that established design requirements for the subject medium voltage cables. However, the technical specifications under which the cables were purchased require the cables to be suitable for installation in a nuclear power plant, indoors and outdoors in metal tray, conduit, and underground duct banks (manholes are part of the underground duct bank), and direct buried in wet and dry locations. These purchase specification requirements clearly indicate the cable must be designed for installation in underground wet locations, and that the cables are expected to be wet.

b. The LRA is amended to state that the testing interval will be based on operating experience but will not exceed 10 years. The 10-year interval for testing recommended in GALL Section XI.E3 is adequate as the base testing interval because the aging degradation process is slow, and, to date, the insulation used on the SSES cables has performed well across the industry. However, this change to the LRA reflects the fact that the testing interval can, and will be, adjusted by evaluations of test results performed under the plant corrective action program. A trend in cable test results is currently being monitored and additional testing has been performed on a circuit that is not within the scope of license renewal. Using information available today, it is not practical to establish a more specific frequency for performance of cable tests during the period of extended operation.

The LRA is amended as follows to change the cable testing interval.

B.2.43 Non-EQ Inaccessible Medium-Voltage Cables Program

➢ The following text under the, Aging Management Program Elements, heading (on LRA page B-131) is revised by addition (***bold italics***).

• Detection of Aging Effects

The Non-EQ Inaccessible Medium-Voltage Cables Program will provide for the testing of in-scope medium-voltage cables to detect degradation of the conductor insulation. The program will utilize a proven test for detecting deterioration of the cable insulation due to wetting (and energization). The program will also conduct inspections of the applicable electrical manholes, to detect water collection and to drain the manholes (if necessary).

The cable testing ***frequency will be based on plant operating experience, but*** will be performed ***at least*** once every 10 years, with the first test to occur during the 10-year period prior to the end of the current operating license. The manhole inspection frequency will be based on actual plant operating experience with water accumulation in the manholes, but will be performed at least once every two years. The first inspections will occur during the 10-year period prior to the end of the current operating license.

c. The manhole inspection frequency will be adjusted based on the results of the inspections. A maximum interval of two years is established for all manholes within the scope of the program. Maximum allowable water levels will be established for each manhole prior to the first inspection under this aging management program (AMP). If the allowable water levels are exceeded, the condition will be entered into the corrective action program for evaluation. The evaluation will take into account the observed conditions from the inspection and any history of water accumulation and adjust the frequency of inspections as needed.

d. Conditions of significant moisture in these manholes are currently under evaluation in the SSES corrective action program.

RAI B.2.43-3:

The GALL Report AMP XI.E3 recommends the technical information and guidance in NUREG/CR-5643, IEEE Std. P1205, SAND 96-0344 and EPRI TR-109619. In the LRA AMP B.2.43, the applicant states that its program is consistent with the GALL Report and yet it did not provide any information on industrial technical guidance. Provide technical guidance for AMP B.2.43 or provide a justification of why this guidance is not necessary.

PPL Response:

The technical documents listed in GALL AMP XI.E3 (NUREG/CR-5643, IEEE Standard P1205, SAND96-0344, and EPRI TR-109619) provide information pertinent to plant environmental conditions, environmental effects (particularly with regard to adverse environmental conditions), evaluation of environmental conditions and effects,

degradation mechanisms, and aging effects. The information is relevant to the understanding of electrical cable aging mechanisms and effects, and is also relevant to potential testing methods to identify degradation. The technical guidance contained in these NRC and industry reports will be used as input to develop this AMP.

RAI B.2.43-4:

The GALL Report AMP XI.E3, under "detection of aging effects" attribute, states that the specific type of test is to be a proven test for detecting deterioration of the insulation system due to wetting, such as power factor, partial discharge, or polarization index, as described in EPRI TR103834-P1-2, or other testing that is state-of-the-art at the time of the test is performed. LRA Section B.2.43, under the same attribute, states that the program will utilize a proven test for detecting deterioration of the cable insulation due to wetting (and energization) and will reflect the actual test methodology prior to the initial performance of the cable testing. Describe the proposed testing methodology for detecting deterioration of the cable insulation under this AMP.

PPL Response:

The LRA states that this is a new program that will be implemented consistent with GALL. Therefore, as recommended in GALL, a proven test for detecting deterioration of the insulation system such as, power factor, partial discharge, polarization index, as described in EPRI TR103834-P1-2, or other state-of-the-art testing will be used. The test method will be selected prior to performance of the first test and will be a test type consistent with the recommendations of GALL.

RAI B.3.2-1:

In the LRA section A.1.3.4, the applicant provided an updated FSAR supplement of summary description of environmental qualification of electrical equipment. This summary description is not consistent with that in Table 4.4.2 of SRP-LR as it does not contain reanalysis attributes. Reanalysis must address attributes of analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, corrective actions if acceptance criteria are not met, and the period of time prior to the end of qualified life when the reanalysis will be completed. Please revise the FSAR supplement description to include these reanalysis attributes.

PPL Response:

LRA section A.1.3.4 is revised as follows to include the reanalysis attributes.

A.1.3 Evaluation of Time-Limited Aging Analyses

➢ LRA Section A.1.3.4 (on LRA page A-29) is revised by addition (***bold italics)***.

A.1.3.4 Environmental Qualification of Electric Equipment

Environmental Qualification analyses for those components with a qualified life of 40 years or greater are identified as TLAA for SSES. NRC regulation 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants" requires licensees to identify electrical equipment covered under this regulation and to maintain a qualification file demonstrating that the equipment is qualified for its application and will perform its safety function up to the end of its qualified life.

10 CFR 50.49 requires EQ components that are not qualified for the current license term to be refurbished, replaced, or have their qualifications extended prior to reaching the aging limits established in the aging evaluation. Reanalysis of aging evaluations to extend the qualifications of components is performed on a routine basis as part of the EQ Program. Important attributes for the reanalysis of aging evaluations include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, corrective actions (if acceptance criteria are not met), and the time remaining to the end of qualified life.

The SSES EQ Program is an existing program that implements the requirements of 10 CFR 50.49 and will be used to manage the effects of aging on the intended function(s) of the components associated with EQ TLAA for the period of extended operation.

RAI 3.6-1:

The GALL Report Item VI.A-8, identifies corrosion and fatigue as one of aging effect/mechanism for fuse holders (metallic clamp) that requires an AMP (GALL XI.E5). The LRA, Section 3.6.2.3.1, states that the fuse holders are located in metallic electrical boxes (terminal boxes) which have covers that protect the interior of the box from the environment. The LRA further states that by design, these fuses are not removed more than once per year, therefore, fatigue due to frequent manipulation does not apply.

a. Explain why corrosion of fuse holders inside the metallic electrical boxes due to condensation is not an aging effect requiring management for fuse holders (metallic clamps).

b. Given the life of the plant is 40 years plus 20 years of extended operations, the fuse holders could be subject to about 60 times of manipulation (removing and inserting of fuse elements to fuse holders). Provide technical justification of how the manipulation of 60 times will not create fatigue aging effect.

PPL Response:

a. Corrosion (due to condensation) in the metallic electrical boxes housing the in-scope fuses subject to aging management review (AMR) is not expected because the boxes are located in a controlled indoor environment and contain no components that experience temperatures less than ambient. Inspection of a sample of the 20 in-scope metal electric boxes containing the fuse holders subject to AMR showed no corrosion or evidence of water intrusion or collection. The metallic electrical boxes were clean and dry.

b. The additional 20 cycles of fuse removal and insertion in fuse holders, where the fuse is removed once per year, is not expected to create a fatigue aging effect on the fuse holder clips. This conclusion is based on engineering judgment when considering the threshold for low cycle fatigue and the material properties of a typical fuse clip.

   As stated in EPRI, 1003056, "Non-Class 1 Mechanical Implementation Guidelines and Mechanical Tools," Appendix H, Page 1-1, "Low cycle fatigue failure might occur after fewer than 10,000 cycles but only if strains exceed the yield strain." This statement suggests that absent of excessive strain, low cycle fatigue would not be expected until after thousands of cycles, which is many more than the number of cycles projected for the SSES fuse clips in the scope of this AMP. The fuse clip material properties determine what constitutes excessive strain. Because the fuse clips are made from a spring material, it is expected that the alloys used to manufacture the clips will have fairly high yield strengths.

   Engineering judgment indicates that the strain created during removal and insertion of the fuse is well below the yield strain of the fuse clip material. A fatigue aging effect on the fuse holder clips is not expected due to the additional 20 cycles of manipulation. The lack of excessive strain and the fact that the total number of cycles on the spring clips is very low, as compared to thousands of cycles expected for onset of low cycle fatigue, is the basis for this judgment.

RAI 3.6-2:

Please explain how the tests were conducted at Ontario Hydroelectric and explain in detail how SSES transmission conductors are bounded by the tests conducted at Ontario Hydroelectric and will have adequate margin for 60 years.

PPL Response:

The papers describing the Ontario Hydro tests and results are available from the Institute of Electrical and Electronics Engineers (IEEE). They were published as Part I and Part II of "Aged ACSR Conductors" in the "IEEE Transactions on Power Delivery," Vol. 7, No. 2, April 1992, pages 581-595. The relevant conclusion of the papers for SSES is "For planning purposes a mean useful life of 70 years is considered valid for existing conductors."

The tests for Ontario Hydro were conducted in the field and in the laboratory. A non-destructive corrosion detector was modified for live line measurement of the loss of galvanizing from the steel cores of the ACSR conductors. The field measurements were performed using a motorized overhead line corrosion detector that traveled along the transmission line. Samples of the conductors tested in the field also were examined in the lab, through tests of fatigue, tensile strength, torsional ductility, and electrical performance. The fatigue and tensile strength testing involved the use of a dynamometer and an electromagnetic shaker, with the conductor strung across a suspension assembly.

The National Electric Safety Code (NESC) requires that the maximum tension of installed conductors shall not be more than 60% of the rated breaking strength under NESC design conditions. NESC design conditions (known as NESC Heavy for all of Pennsylvania) include simultaneous consideration of ice, wind, and temperature. PPL design criteria for 230kV transmission lines are even more demanding than NESC Heavy (1" radial ice versus ½" radial ice and a simultaneous 8 psf wind versus 4 psf wind). This conductor loading is higher than NESC and, like NESC, must not exceed 60% rated breaking strength.

Conductor loading requirements are reviewed below for the Startup Transformer #10 230kv Tap and for the 230kV/500kV Yard Tie, which operates at 230kV.

Both of these lines utilize 1590 kcmil Lapwing 45/7 ACSR conductors. 1590 describes the cross-sectional area of the conductor in kcmils (1 kcmil = 1000 circular mils, and one circular mil = the cross-sectional area of a circle 1 mil in diameter.) Lapwing is the common industry name for this conductor. The 45/7 means the conductor has 45 outer strands of aluminum conductor around a two-layer core consisting of 7 strands of galvanized steel wire. The "ACSR" means "aluminum conductor steel reinforced." The ultimate strength (rated breaking strength) of Lapwing is 42,200 lbs.

Based on a design maximum tension of 21,537 lbs for the Startup Transformer #10 230kV Tap, the margin between the maximum conductor load and the ultimate conductor strength is 20,663 lbs.; therefore, the margin for ultimate strength is 49%.

The Ontario Hydro study showed a 30% loss of composite conductor strength in the typical 70 year-old conductor. In the case of the Lapwing transmission conductors, a

30% loss of ultimate strength would mean that there would still be adequate margin (46%) between the design maximum load of 21,537 pounds and the eventual conductor strength of 33,085 pounds for the Startup Transformer #10 230kV Tap (1.12 x 42,200 x 0.7). As noted by Ontario Hydro, "new conductors show an average strength of 112% of rated tensile strength."

The 230 kV / 500 kV Yard Tie line has a design maximum conductor tension of 16,000 lbs., and thus, an even greater margin. Both transmission lines exceed the design requirements set forth by the NESC. Therefore, the expected margin at 70 years of age is adequate for these installed transmission conductors at SSES.

Transmission conductor samples tested in the Ontario Hydro Test included samples with 45/7 stranding and are representative of the installed conductors at SSES, so the conclusions from the Ontario Hydroelectric Test Report for the remaining strength after 70 years of installation are both conservative and valid for SSES. Therefore, loss of conductor strength due to corrosion of the transmission conductors is not an aging effect requiring management for the period of extended operation.

RAI 3.6-3:

The LRA Section 3.6.2.2.3 states that bolted connections associated with transmission conductors employ the use of good bolting practices consistent with the recommendation of EPRI 1003471, "Electrical Connector Application Guidelines." In addition, it stated that bolting hardware is selected to be comparable with the lugs used on transmission conductors and Belleville washers are used to compensate for temperature change and to maintain proper tightness.

a. Describe good bolting practice as recommended in EPRI 1003471 and how the bolted connections associated with transmission conductor at SSES follows this recommendation.

b. The EPRI document TR-104213, "Bolted Joint Maintenance & Application Guide," identifies a special problem with Belleville washers. It states that hydrogen embrittlement is a recurring problem with Belleville washers and other springs. When springs are electroplated, the plating process forces hydrogen into the metal grain boundaries.

   If the hydrogen is not removed, the spring may spontaneously fail at any time while in service. Describe the types of finish the Belleville washers currently have at SSES and current activities used to confirm the effectiveness of switchyard bolted connections.

c. Increased resistance on connection due to oxidation may occur in transmission conductors and connections and in switchyard buses and connections. Explain

why increased connection resistance of switchyard connections is not identified as an aging effect requiring management at SSES.

PPL Response:

a. The following bolted connection practices are used at SSES to ensure integrity of transmission conductor bolted connections. These practices are consistent with the design and assembly guidance in EPRI 1003471.

- Washers are used between the connector and bolt heads and nuts to protect the surface of the connector when the bolt is turned.
- Belleville washers are used to keep the load on the connection as the connectors and bolting materials respond to heat up and cool down.
- The use of Belleville washers is predetermined for certain connector and bolting material combinations and specified in the construction specifications.
- Contact surfaces are cleaned, scoured (except plated surfaces) to remove any oxide coating, wiped with a dry clean cloth, and immediately coated with an oxide inhibiting joint compound.

The bolting practices used for SSES transmission conductor connections have been proven by reliable operation of the transmission system and the switchyards associated with SSES.

b. The Belleville washers in use with the SSES transmission conductors are stainless steel and are not electroplated. Therefore, they are not subject to the hydrogen embrittlement aging effect. Switchyard bolted connections are routinely inspected using thermography to confirm effectiveness of the connection.

c. Increased connection resistance of switchyard connections due to oxidation is not identified as an aging effect requiring management because of the use of good bolting practices that include proper cleaning of the contact surfaces, application of oxide inhibiting compound, and use of appropriate hardware to ensure the connection remains tight. These bolting practices minimize the formation of an oxide layer directly at the contact point.

RAI 3.6-4:

Tie wraps may be taken credit for in seismic analysis and in plant design specifications primary for separation to preclude ampacity degrading. Operating experience has identified issues with tie wraps, such as, tie wraps were brittle, degraded, or missing and tie wraps failures affected safety functions of other system/components. The LRA does not discuss tie wraps as a commodity type requiring aging management reviews (AMRs). Explain why tie wraps are not required an AMR. Respond to the following:

a. Are tie wraps taken credit for seismic analysis in the current licensing basis?

b. Address the effects of tie wraps for 10 CFR 54.4 (a)(2) over 10 CFR 54.4(a)(1), non safety components whose failure could affect safety-functions.

c. Provide a quantitative analysis of the effects of cables spacing not being maintained as original design specifications (due to tie wraps failure). The analysis should provide the worst case scenario with ampacity reduction and the maximum amperes required for motors to start and run during a design basis accident.

PPL Response:

a. A review of current licensing basis documentation revealed that SSES does not credit tie wraps in the seismic qualification of cable trays.

b. SSES considered the potential effect on safety-related equipment caused by the failure of plastic cable tie-wraps due to age-related degradation and concluded that the failure of tie wraps that could prevent satisfactory accomplishment of the functions of structures, systems and components (SSCs) identified under 10 CFR 54.4(a)(1) is not credible for the following reasons.

- A review of SSES operating experience did not reveal any instances of equipment failures due to degradation of electrical cable tie wraps.
- Sensitive components that could be impacted by a loose tie wrap are installed within protective enclosures.
- SSES employs good housekeeping and foreign material exclusion (FME) practices.
- The results of a review of industry operating experience associated with tie wraps were documented in an RAI response by Wolf Creek Generating Station (ML07228073). This review found only two occurrences of component failures due to tie wraps, and both occurred within active components.

Reviews of SSES and industry operating experience did not reveal any occurrences of equipment failures caused by tie wraps outside of active components. Therefore, failure of tie wraps resulting in impact to safety functions is considered a hypothetical failure and based on current license renewal guidance does not need to be considered further for license renewal.

c. Based on a review of SSES CLB documentation, including the FSAR, Design Basis Documents, cable installation specifications, and design calculations, electric cable ties are not credited for spacing of cables at SSES. Cable ampacity ratings are based

on cable tray fill, cable loading depth, cable diameters, and the number of conductors. Cables are assumed to be organized randomly in the tray and spacing between cables is not a consideration. Therefore, cable tie wraps are not credited in the SSES design for cable ampacity ratings.

RAI 3.6-5:

The LRA Section 3.6.2.2.2 states that the high-voltage insulators within the scope of license renewal for SSES are connected to rigid components, such that significant movement is not considered as a stressor, and wear is not identified as an aging mechanism. Describe what components are connected to the insulators and explain why wear is not identified as an aging mechanism. Also provide plant specific operating experience with high-voltage insulators at SSES.

PPL Response:

LRA Section 3.6.2.2.2 was revised in response to RAI 2.5-1 as documented in Reference 3, (ADAMS ML081420028). The amended LRA includes high-voltage insulators in addition to those connected to rigid components. Based on the amended LRA, the components connected to the SSES high-voltage insulators within the scope of license renewal are transmission conductors, transmission towers, dead end structures, switchyard disconnect switches, motor-operated disconnect switches in the transformer yard, and structural supports.

An explanation for "why wear is not identified" as an aging mechanism for strain insulators was included in Reference 3. Essentially, wear is not identified as an aging mechanism for station post insulators used to support short lengths of switchyard transmission cable and components such as disconnect switches, because there is no movement involved, and consequently no wear. All connections to station post insulators are solid bolted connections, such that there is no movement.

A review of the SSES operating experience did not reveal any failures of high-voltage insulators due to wear, or any significant issues associated with wear.