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10CFR54

April 29, 2002

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Peach Bottom Atomic Power Station, Units 2 and 3
Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Subject: Response to Request for Additional Information Related to Aging Management of Electrical and Instrumentation and Controls

Reference: Letter from R. K. Anand (USNRC) to M. P. Gallagher (Exelon), dated January 23, 2002

Dear Sir/Madam:

Exelon Generation Company, LLC (Exelon) hereby submits the enclosed responses to the request for additional information transmitted in the reference letter. For your convenience, Attachment 1 restates the questions from the reference letter and provides our responses.

If you have any questions or require additional information, please do not hesitate to call.

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

Respectfully,

Executed on 5/2/02

Michael P. Gallagher
Director, Licensing & Regulatory Affairs
Mid-Atlantic Regional Operating Group

Enclosures: Attachment 1

cc: H. J. Miller, Administrator, Region I, USNRC
A. C. McMurtray, USNRC Senior Resident Inspector, PBAPS

A001

ATTACHMENT 1

3.6 Aging Management of Electrical and Instrument and Control

RAI 3.6-1

Sections 2.5.1, 2.5.2, and 2.5.3 of the LRA evaluate the aging effects applicable for electrical components that can be expected to occur due to: (1) moisture produced water trees, (2) radiation, and (3) heat, depending on environmental conditions. Further, the LRA states that water trees occur when the insulating materials are exposed to long term standing water, energized more than 25 percent of the time, be of medium voltage, and contained void or impurity. These trees eventually result in breakdown of the dielectric materials and ultimate failure. However, the LRA concludes that because Peach Bottom replaced suspected cables subjected to the water treeing criteria in 1995 and no cable failures have occurred since the replacement program was initiated, there is no need for the requirement for aging management program for medium voltage cable and connections. On January 2, 2002, you have provided summary of a paper entitled "An Assessment of Field Aged 15kV and 35KV Ethylene Propylene Rubber Insulated Cables" published in the 1994 T & D conference Proceedings in support of not having an aging management program for medium voltage cables exposed to an adverse localized environmental caused by moisture produced water trees and voltage stress. It is not clear to the staff that the above information is adequate for not having an AMP for medium voltage cables exposed to an adverse localized environmental caused by moisture produced water trees and voltage stress. However, the staff agrees that an AMP is not required if the cables were specifically designed for use in wet environments.

The LRA also concludes that because the maximum operating doses (1.5 times the existing radiation design value plus accident dose) of insulation material will not exceed the 60 year service limiting environment-radiation dose and because the maximum operating temperature of insulation material will not exceed the maximum temperature for 60 year life, no aging management are required for heat or radiation. Additionally, on January 2, 2002, you have stated that a plant walkdown was conducted outside containment (i.e., excluding drywell and steam tunnel) to identify any adverse localized equipment environments. It was concluded that only the PVC cables in the drywell credited for fire safe shutdown required an aging management activity. This conclusion is not consistent with the aging management program and activities for electrical cables and connections exposed to adverse localized environments caused by moisture, heat or radiation.

Most electrical cables in nuclear power plant are located in dry environments. However, some cables may be exposed to condensation and wetting in inaccessible locations, such as conduits, cables trenches, cable troughs, duct banks, underground vaults or direct buried installations. When energized medium voltage (2 kV - 15 kV) cables not specifically designed for submergence are exposed to these conditions, water treeing or a decrease in dielectric strength of the conductor insulation can occur. This can potentially lead to electrical failure. The radiation levels most equipment experience during normal service have little degrading effect on most insulation materials. Design basis calculations or evaluations bound the expected radiation doses for all plant areas. These evaluations usually account for additional doses seen in these areas due to infrequent operation line-up. However, some localized areas may experience higher than expected radiation condition. Typical areas prone to elevated radiation levels include areas near primary reactor coolant system piping or the reactor

pressure vessel, areas near waste processing systems and equipment, and areas subject to radiation streaming. The most common adverse localized equipment environments are those created by elevated temperature. Elevated temperature can cause equipment to age prematurely, particularly equipment containing organic materials and lubricants. The effects of elevated temperature can be quite dramatic.

Therefore, for non-EQ cables and connections (connectors, splices, and terminal blocks) within the scope of license renewal located in the turbine building, intake structure, main steam and feedwater platforms, yard structures, containment, the diesel generator building, and the auxiliary building, provide a description of the following:

An aging management program for accessible and inaccessible electrical cables and connections exposed to an adverse localized environmental caused by heat or radiation.

An aging management program for accessible and inaccessible electrical cables used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance exposed to an adverse localized environment caused by heat or radiation.

An aging management program for accessible and inaccessible medium-voltage (2kV to 15kV) cables (e.g., installed in conduit or direct buried) exposed to an adverse localized environmental caused by moisture-produced water trees and voltage stress.

Response to RAI 3.6-1

The applicant will address these issues individually as follows:

(1) An aging management program for accessible and inaccessible electrical cables and connections exposed to an adverse localized environmental caused by heat or radiation.

We understand that the NRC, in the above RAI, is requesting a program similar to the GALL Report, Program X1.E1, "Electrical Cables and Connections Not Subject to 10CFR 50.49 Environmental Qualification Requirements."

Based on the guidance in EPRI TR-109619, "Guideline for the Management of Adverse Localized Equipment Environments", it has been found that plant operating experience (i.e., a study of plant problem reports) and visual inspections are two methods of identifying adverse localized equipment environments (or hot spots).

As discussed in our letter, "Information to Resolve Electrical Issues on the License Renewal Application", dated 1/2/2002, from Michael P. Gallagher to the NRC Document Control Desk, a plant walk down was performed outside containment (i.e., not in the drywell or steam tunnel). The purpose of the walk down was to take local temperature data and look for adverse localized equipment environments. The equipment used was a digital thermometer, and an infrared camera. No adverse localized equipment environments (e.g., cables within 3 feet of hot process piping) as described in EPRI document TR-109619 were identified during the plant walkdown.

Additionally, review of Peach Bottom Atomic Power Station (PBAPS) plant operation experience did not identify any non-EQ cable and connector failures due to adverse localized equipment environments.

As discussed in the LRA, Section 2.5-1, and Exhibit 2.5-1, non-EQ cables in the Steam Tunnel were reviewed to identify if they supported any in-scope License Renewal loads. None were identified.

As discussed in the LRA, Section 2.5-1, and Exhibit 2.5-1, non-EQ cables in the Drywell were reviewed to identify if they supported any in-scope License Renewal loads. An "adverse localized equipment environment" was identified in the Drywell for certain PVC cables. Through cable aging management review, the Drywell was found to be the only "adverse localized equipment environment" at PBAPS for in- scope, non-EQ cables. These cables in the Drywell are PVC insulated cables, and are used to provide Safety Relief Valve discharge temperatures to control room temperature recorders in support of Fire Safe Shutdown (FSSD). The FSSD cables have their own aging management program as described in the LRA, Section B.3.2.

Although the applicant believes a thorough review of cable insulation types was performed against the PBAPS design parameters for temperature and radiation in the presence of oxygen, and a plant walk-down did not identify any adverse localized equipment environments outside the Drywell or Steam Tunnel, and, additionally, provides reasonable assurance that no adverse localized equipment environments exist outside the Drywell or Steam Tunnel, the applicant will agree to implement a non-EQ cable inspection program consistent with GALL Program X1.E1.

Section 3.6, Table 3.6-1 of the LRA will be revised as shown below to reflect this new activity. Since all accessible cables installed in an adverse environment, including power, control, and instrumentation cables, (and associated insulation types) will be inspected, Table 3.6-1will not differentiate between insulation types as is shown in the original application.

Table 3.6-1 Aging Management Review Results for Cable

Component Group	Component Intended Function	Environment	Materials of Construction	Aging Effect	Aging Management Activity
Electrical Cables	Electrical Continuity	Sheltered	Metallic conductor with various organic insulation types (XLPE, EPR, EP, SR, etc.)	Loss of Material Properties	Non-EQ Accessible Cable Aging Management Activity (B.3.3)
Electrical Cables	Electrical Continuity	Sheltered	Metallic conductor with polyvinyl chloride (PVC) insulation	Loss of Material Properties	**FSSD Cable Inspection (B.3.2)**

Section 3.6, Table 3.6-2 of the LRA will be revised as shown below to reflect this new activity.

Table 3.6-2 Aging Management Review Results for Connectors, Splices, and Terminal Blocks

Component Group	Component Intended Function	Environment	Materials of Construction	Aging Effect	Aging Management Activity
Electrical Connectors - Insulation	Electrical Continuity	Sheltered	Various organic insulation types (discussed in Section 2.5.1)	Loss of Material Properties	Non-EQ Accessible Cable Aging Management Activity (B.3.3)
Electrical Connectors - Metallic Connector	Electrical Continuity	Sheltered	Copper, tinned copper, and aluminum.	None (2)	Not Applicable.
Electrical Splices - Insulation	Electrical Continuity	Sheltered	Modified Polyolefin (XLPO, XLPE)	Loss of Material Properties	Non-EQ Accessible Cable Aging Management Activity (B.3.3)
Electrical Terminal Blocks - Insulation	Electrical Continuity	Sheltered	Phenolic and nylon insulation	Loss of Material Properties	Non-EQ Accessible Cable Aging Management Activity (B.3.3)
Electrical Terminal Blocks- Metallic	Electrical Continuity	Sheltered	Copper, tinned copper, brass, bronze & aluminum	None (2)	Not Applicable

(2) No aging effect for PBAPS

Appendix B.3, "New Aging Management Activities" is revised as shown below to reflect this new activity.

B.3.3 Non-EQ Accessible Cable Aging Management Activity

Activity Description

Cables and connections (for power, control, and instrumentation) in accessible areas (easily approached and viewed) are visually inspected and represent, with reasonable assurance, all cables and connections in the potential adverse localized environment. If an unacceptable condition or situation is identified for a cable or connection in the areas inspected, a determination is made as to whether the same condition or situation is applicable to other accessible or inaccessible cables or connections.

Evaluation and Technical Basis

1. Scope of Program: This inspection program applies to accessible electrical cables and connections (power, control, and instrumentation) within the scope of license renewal that are installed in adverse localized environments caused by heat or radiation in the presence of oxygen.

2. Preventive Actions: This is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.

3. Parameters Monitored/Inspected: A representative sample of accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable and connection jacket surface anomalies, such as embrittlement, discoloration, cracking, or surface contamination.

4. Detection of Aging Effects: Conductor insulation aging degradation from heat, radiation, or moisture in the presence of oxygen causes cable and connection jacket surface anomalies. Accessible electrical cables and connections installed in adverse localized environments are visually inspected at least once every 10 years. This is an adequate period to preclude failures of the conductor insulation since experience has shown that aging degradation is a slow process. A 10-year inspection frequency will provide two data points during a 20-year period, which can be used to characterize the degradation rate. The first inspection for license renewal is to be completed before the period of extended operation.

5. Monitoring and Trending: Trending actions are not included as part of this program because the ability to trend inspection results is limited.

6. Acceptance Criteria: The accessible cables and connections are to be free from unacceptable, visual indications of surface anomalies, which suggest that conductor insulation or connection degradation exists. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss of the intended function.

7. Corrective Actions: Identified deviations will be evaluated within the PBAPS corrective action process, which includes provisions for root cause determinations and corrective actions to prevent recurrence as dictated by the significance of the deviation.

8. ***Confirmation Process:*** The PBAPS corrective action process includes:
Reviews to assure that proposed actions are adequate;
Tracking and reporting of open corrective actions; and
For root cause determinations, reviews of corrective action effectiveness.

9. ***Administrative Control:*** All credited aging management activities are subject to administrative controls, which require formal reviews and approvals.

10. ***Operating Experience:*** Industry operating experience has shown that adverse localized environments caused by heat or radiation for electrical cables and connections may exist next to or above (within three feet of) steam generators, pressurizers or hot process pipes, such as feedwater lines. These adverse localized environments have been found to cause degradation

of the insulating materials on electrical cables and connections that is visually observable, such as color changes or surface cracking. These visual indications can be used as indicators of degradation. No age-related insulated non-EQ cable failures due to adverse localized equipment environments have occurred at PBAPS.

Summary

The Non-EQ accessible cable aging management activity will be performed once every ten years, beginning prior to the period of extended operation. This inspection activity will provide reasonable assurance that the intended functions of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse localized environments caused by heat or radiation will be maintained consistent with the current licensing basis through the period of extended operation.

REFERENCES

(1) EPRI Report TR-109619, "Guideline for the Management of Adverse Localized Equipment Environments", Palo Alto, CA, June 1999

Appendix A.3.3 has been added as shown below to reflect this new activity.

APPENDIX A UPDATED FINAL SAFETY ANALYSIS REPORT (UFSAR) SUPPLEMENT

A.3.3 Non-EQ Accessible Cable Aging Management Activity

The Non-EQ accessible cable aging management activity will visually inspect all cables and connections in accessible areas (easily approached and viewed) in the potential adverse localized environment. The Non-EQ accessible cable aging management activity will be performed once every ten years, beginning prior to the period of extended operation. This inspection activity will provide reasonable assurance that the intended functions of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse localized environments caused by heat or radiation will be maintained consistent with the current licensing basis through the period of extended operation.

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(2) An aging management program for accessible and inaccessible electrical cables used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance exposed to an adverse localized environment caused by heat or radiation.

We understand that the NRC, in the above RAI, is requesting a program similar to the GALL Report, Program X1.E2, "Electrical Cables Not Subject to 10CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits."

GALL Report, Program XI.E2, "Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits", uses routine calibration tests

performed as part of the plant surveillance test program to identify the potential existence of aging degradation of cables and connections used in low-level signal applications that are sensitive to reduction in insulation resistance (IR) such as radiation monitoring and nuclear instrumentation. Program XI.E2 is based on the program implemented at Calvert Cliffs as documented in Section 3.12.3.2.3 of NUREG-1705, the Calvert Cliffs license renewal SER.

Although credited during the Calvert Cliffs license renewal application review, other plants since have not credited this program for managing the effects of aging of circuits sensitive to a reduction in IR. This is likely due to the fact that the inspection program XI.E1, which looks at mechanical and physical properties, is much better able to detect early material degradation than testing program XI.E2, which looks at electrical properties. As discussed in Section 5.2.2 of the SAND96-0344, "Aging Management Guideline for Commercial Nuclear Power Plants – Electrical Cables and Terminations," dated September 1996 (underline added for emphasis):

Section 5.2.2, Measurement of Component or Circuit Properties, (page 5-4) states, in part, "Diagnostic techniques to assist in assessment of the functionality and condition of power plant cables and terminations are described in this section...."

"Significant changes in mechanical and physical properties (such as elongation-at-break and density) occur as a result of thermal- and radiation-induced aging. For low-voltage cables, these changes precede changes to the electrical performance of the dielectric. Essentially, the mechanical properties must change to the point of embrittlement and cracking before significant electrical changes are observed...."

GALL Report, Program XI.E2, pertains to instrumentation circuits that are sensitive to reductions in insulation resistance (IR). These are a subset of the cables covered by inspection program XI.E1 since both programs (XI.E1 and XI.E2) are identified in GALL Report Table VI.A (pages VI. A-3 and A-4) as managing aging effects caused by heat and radiation that can lead to reduced insulation resistance (IR). According to GALL Report Table VI.A (page VI A-3), program XI.E1 manages "Aging Effects/Mechanisms" that lead to "reduced insulation resistance" with "Further Evaluation" not required.

Visual inspection can detect aging degradation early in the aging process whereas embrittlement and cracking must occur before significant electrical property changes, such as reduced insulation resistance, would be detected through circuit calibration.

The industry understands that these two GALL programs (XI.E1 and XI.E2) manage the same aging effects for the same cables in different ways. This is seen as providing an applicant with the ability to pick the program that best fits the needs identified at the plant, but that both programs would not be required to adequately manage aging of plant cables. The first two applicants illustrated this, where Calvert Cliffs committed to the calibration program (XI.E2) but not to the inspection program, and where Oconee committed to the inspection program (XI.E1), but not to the calibration program. This was the pattern or precedent that the industry saw and understood as being included in the GALL Report - two programs that cover the same cables using different methods to manage aging with the applicant able to choose a program that best fits the plant aging management requirements.

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(3) An aging management program for accessible and inaccessible medium-voltage (2kV to 15kV) cables (e.g., installed in conduit or direct buried) exposed to an adverse localized environmental caused by moisture-produced water trees and voltage stress.

We understand that the NRC, in the above RAI, is requesting a program similar to the GALL Report, Program X1.E3, "Inaccessible Medium-Voltage Cables Not Subject to 10CFR 50.49 Environmental Qualification Requirements."

PBAPS elected to replace cables "suspect" to water-treeing. Since the replacement cables were suitable for use in wet environment, the applicant believes that moisture is not an aging effect requiring management at PBAPS, as discussed below.

Certain electrical cable insulations can experience a phenomenon known as "water treeing", that could lead to failure of some identified types of cable insulation, under a collective series of conditions. One of those conditions involves an installed environment exposed to long-term wetting or high moisture. This phenomenon does induce a *"Loss of Material Properties"* to specific cable insulation materials.

The water-treeing phenomenon is a slow process by which a breakdown of the cable insulation properties may, or may not, lead to a cable failure. The cable must be exposed to the combination of <u>all</u> of the following conditions for water treeing to occur:

1. A cable insulation material void or impurity (inclusion, flaw) must be present in the cable insulation.

2. The phenomenon predominantly affects only "medium voltage" (5kV-15kV) cables.

3. The presence of an electrical field on "lightly" loaded, but continuously energized cables.

4. The presence of continuous (long term) moisture.

Water treeing affects cable insulation materials having an ethylene polymer base. Water treeing has been shown to occur predominately in cables with Cross-linked Polyethylene (XLPE) insulation. Since the recognition and understanding of the water treeing phenomenon by the cable manufacturers and the utility industry in the late 1970s, improved formulations (resistant to water treeing) of XLPE cable insulations for use in underground applications have been made available and used since 1980.

PBAPS experienced a series of non-safety related cable failures between 1984 and 1991, when XLPE insulated 5kV and 15kV cables failed with no cause initially identified. Analyses identified that one failure, occurring in 1991, was attributable to water treeing. Further analyses on other cable samples were conducted, and evidence of water trees were found in six cases. The "trees" were found to be extensive in some cases.

A cable replacement program was initiated at PBAPS in 1995, and completed in 1999 on "suspect" cables subjected to the collective conditions listed above.

The replacement cable was ethylene propylene copolymer (EPR) insulated cable, pink in color, which has a low level of crystallinity with a poly-vinyl-chloride (PVC) jacket, suitable for use in wet or dry locations in conduit, underground duct systems, or direct buried, or aerial installations. The cables are rated for a minimum of 90° C for normal operation, 130° C for emergency loading operation, and 250° C for short circuit conditions.

The basic construction of the cable is either single conductor class B strand bare copper or aluminum, with extruded semi-conducting strand screen, EPR insulation, extruded semi-conducting insulation screen, bare copper shielding tape, and PVC jacket.

Review of a paper entitled "An Assessment of Field Aged 15KV and 35KV Ethylene Propylene Rubber Insulated Cables", by authors Carlos Katz and Michael Walker, published in the 1994 T&D Conference Proceedings, Pages 652-658, provided the following information and conclusions:

1."As evidenced by numerous data, including ac and impulse voltage breakdown strength, a newer (< 15 years old) EPR cable performs significantly better than an older EPR (containing carbon black in its compound) made by the same manufacturer."

2."Based on extrapolation of the voltage-time curves (obtained from cables in service) it is estimated that the newer EPR (EP) cable in this study will have a useful service life in excess of 30 years."

Review of the manufacturer's Product Data Sheet, Section 2, Sheet 9, for "Okoguard-Okoseal Type MV-90 cable, under the paragraph entitled "Applications", it states, "Type MV cables may be installed in wet or dry environments, indoors or outdoors, (exposed to sunlight), in any raceway or underground duct," Under the paragraph entitled "Product Features", it additionally states, "triple tandem extruded, all EPR system, Okoguard cables meet or exceed all recognized industry standards (UL, AEIC, NEMA/ICEA, IEEE), moisture resistant, exceptional resistance to treeing."

The above information is again repeated within the manufacturer's specification, and provides a warrantee of cable failures due to defects in material or workmanship for forty years.

PBAPS believes that choosing the cable as described above, capable of being installed in a wet location, as the replacement cable for the medium voltage 'suspected" cables with the potential for "treeing", removes one of the conditions as described above which must be present for "treeing" to occur.

PBAPS concurs with the NRC comment as stated in RAI 3.6.1, paragraph 1, "... the staff agrees that an AMP is not required if the cables were specifically designed for use in wet environments."

Review of the PBAPS operating history has determined that no additional cable failures, caused by the effects of the "water treeing" phenomena, have occurred at PBAPS since the cable replacement program was completed.

Based on the discussion above, and since the replacement cables were suitable for use in wet environment, the applicant believes that moisture is not an aging effect requiring management at PBAPS.

RAI 3.6-2

Under item (3) Parameters Monitored/Inspected, the LRA stated that the PVC insulation will be visually inspected for surface anomalies such as embrittlement, discoloration, or cracking. Additionally, on January 2, 2002, you have stated that FSSD cables are connected to thermocouples on the discharge of the steam relief valves (SRVs) in the drywell and provide temperature information to a recorder in the control room. You have stated that GALL Program XI.E2, "Electrical Cables Not Subject to 10 CFR 50.49 Environmental Requirements Used In Instrument Circuits" was considered to be an inappropriate activity to identify the potential aging degradation of the PVC insulation for FSSD cables. Visual inspection may not be sufficient to detect aging degradation from heat and radiation in the circuits with sensitive, low level signal. Because low-level signal circuits may operate with signals that are normally in the milliamp range or less, they can be affected by extremely low levels of leakage current. Provide a technical justification how the temperature information to a recorder in the control room will be assured when the cables are aged but do not show visual anomalies.

Response to RAI 3.6-2

The cable inspection activity for the fire safe shutdown (FSSD) cables is not for instrumentation circuits. The FSSD cables are connected to thermocouples on the discharge of the Steam Relief Valves (SRVs) in the drywell, and provide temperature information to a recorder in the control room. The recorder provides both annunciation and input to the plant computer should an input signal go outside a preset allowable range. Although this may be considered a type of instrument circuit, it is not "loop checked" as in the true meaning of an instrument circuit, but provides direct readings into the recorder. The primary concern is with the PVC insulation surrounding the thermocouple metallic conductors, not with the metallic conductors themselves. With that in mind, it was considered that the most appropriate inspection activity would be a visual inspection of PVC insulation consistent with the GALL Report, Program XI.E1, "Electrical Cables and Connections Not Subject To 10CFR 50.49 Environmental Qualification Requirements". The GALL Report, Program XI.E2, "Electrical Cables Not Subject To 10CFR 50.49 Environmental Requirements Used In Instrument Circuits" uses a combination of routine calibration and surveillance tests to identify the potential existence of aging degradation. This was considered to be an inappropriate activity to identify the potential aging degradation of the PVC insulation for FSSD cables.

Based on the above, and the response to part (2) of RAI 3.6-1, Exelon concludes with reasonable assurance that the Appendix B.3.2, FSSD Cable Inspection Activity, which is similar to the GALL X1.E1 program, using visual inspection of the PVC insulation for surface anomalies such as embrittlement, discoloration, or cracking, is an adequate program to manage aging of the FSSD cables to assure that their intended function is maintained during the period of extended operation.

As stated in the summary section of Appendix B.3.2, review of PBAPS operating history did not identify any age related failures of the FSSD cables.