TVA

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U.S. Nuclear Regulatory Commission
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Gentlemen:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

WATTS BAR NUCLEAR PLANT (WBN) - RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI) - ENVIRONMENTAL QUALIFICATION (EQ) SPECIAL PROGRAM

This letter responds to the specific questions provided in three enclosures to NRC's RAI dated May 1, 1992, regarding the TVA WBN EQ Special Program and provides a discussion on the status of the Mechanical Equipment Qualification (MEQ) Special Program. TVA's EQ response is formatted to match the three RAI enclosures. Enclosure 1 addresses three general questions regarding TVA's treatment of certain issues in the WBN EQ Program. Enclosure 2 addresses a number of observations regarding the TVA WBN EQ Binders. Where the observation simply notes the existence of open items in TVA's tracking system, additional information is not provided as these items are closed per the system completion dates. Enclosure 3 addresses questions related to particular EQ binders.

TVA's response reflects the current EQ Binder documentation and provides the NRC staff a basis on which to judge the soundness of the program to date. Accordingly, TVA requests that NRC respond to the enclosed information providing its observations regarding the adequacy of the program from a programmatic viewpoint. TVA's WBN EQ Binders are controlled per Site Standard Practice (SSP)-6.05, "10 CFR 50.49 - Maintaining Electrical Equipment Environmental Qualification." Work is continuing and any changes to the equipment qualification specifics described in the enclosures to this letter will be addressed in accordance with that procedure.

TVA acknowledges receipt of NRC's "Guidance For Submittal On Safety-Related Mechanical Equipment Qualification (MEQ) In A Harsh Environment" transmitted by NRC's letter to TVA dated April 9, 1992. This guidance is being reviewed and addressed within the MEQ Program. TVA agrees that MEQ primarily involves

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individual component parts rather than "whole devices" and, therefore, the MEQ Program is much less complex than the EQ Program. Additionally, TVA is developing the final mechanical equipment list on a system basis in support of Unit 1 startup testing. TVA recognizes the staff's review of the MEQ Program is performed in conjunction with the EQ Program review. Thus, the MEQ list along with the specific elements of the MEQ Program will be available for NRC review during NRC's onsite EQ inspection.

If you have any questions, please telephone P. L. Pace at (615) 365-1824.

Very truly yours,

W.J. Museler

William J. Museler

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50-390/391 WATTS BAR 1&2 TVA

Response to Request For Addl Info re Enviro Qualification (EQ) Special Program

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WATTS BAR NUCLEAR PLANT (WBN)

ENCLOSURE 1
RESPONSE TO REQUEST FOR INFORMATION (RAI) ENCLOSURE 1
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
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GENERAL INFORMATION

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Response To RAI Enclosure 1 - General Information

Question 1

The NRC questioned why some binders state the equipment is qualified, while open items and qualification deficiencies are listed. The NRC stated that the proposed solutions must be implemented before the staff will agree that the item is qualified and in compliance with the applicable regulation.

TVA Response

TVA acknowledges that open items do exist in the EQ binders; however, the binders are prepared to show qualification once the open item is closed. The purpose of stating the open items in each applicable binder is to ensure that the open issue and field work is addressed and properly resolved and documented before Unit 1 achieves initial criticality. This is in line with the Executive Summary of TVA's September 30, 1986 submittal to Mr. Youngblood titled, "Summary Status Update Report of TVA's Compliance to 10 CFR 50.49 - Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants."

TVA agrees that the solution to these deficiencies must be implemented before the Staff can concur that each item is qualified and in compliance with applicable regulations. As discussed in the March 5, 1992 working meeting and the follow-up meeting summary from P. S. Tam, an onsite inspection will take place when implementation nears completion. At that time the technical items will be dispositioned and a significant portion of the EQ-initiated field work complete.

Question 2

The NRC question concerned the use of qualification by similarity, noting various areas for consideration in evaluating similarity.

TVA Response

Similarity of installed equipment to tested equipment is an important facet of qualification. Although explicit regulatory criteria do not exist for such evaluations, appropriate engineering judgement should be employed. The areas noted by the staff in the RAI are factors which may be appropriate for consideration in particular instances.

Typically similarity is shown in WBN EQ binders for equipment manufactured by the same manufacturer; however, this does not preclude presentation of a similarity justification for installed equipment/cables which are not manufactured by the manufacturer of the equipment/cables which were tested. Justifications in the EQ binders are provided with a documented evaluation of the installed device versus the tested device. This evaluation considers such attributes as materials including chemical composition, manufacturing processes, and physical characteristics of the application.

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WBN EQ binders provide similarity evaluations as required in Tab B, titled "EQ Checksheets for Evaluation of Environmental Qualification Including Summary and Conclusion," to confirm qualification of the device. As an example, for the cited EQ Binder CABL-013 for TEFZEL signal cable, similarity is documented for an installed item not manufactured by the same manufacturer as the item tested.

EQ Binder CABL-013, Tab C, titled "Analysis And Justification," discusses the similarity of these cables. The discussion documents the fact that DuPont's Tefzel supplied to the various cable manufacturers is the same product. The cable manufacturers referenced in this binder (to show similarity) have stated that they do not alter the composition of the compound (no additives) in any way and they manufacture their cable in accordance with DuPont's Tefzel guidelines, which establish the basis for production of Tefzel cable. Since the material is the same and the cables are manufactured using the same guidelines, the cables are similar in construction and the test by one manufacturer would qualify the cables from another manufacturer. Additional supporting evaluations and information, including supporting correspondence from DuPont and the cable manufacturers, are provided in Tab E, titled "Qualification Documents," of the binder.

TVA considers the evaluation performed in this instance to demonstrate qualification and to provide sufficient evidence of compliance with applicable regulations.

Question 3
The NRC questioned the use by TVA of certain values of the activation energies in the Arrhenius equation to determine qualified life.

TVA Response
Activation energy is an important parameter in using the Arrhenius equation to determine the qualified life of an item. Standard industry practices are utilized to determine the activation energies for WBN's EQ Program. These methods are:

a. The activation energy is as stated in the test report,

b. The activation energy is calculated based on test data, and

c. A literature search is made to provide the activation energies for the material.

Method c is typically not used when data is available from method a or b. When method c is used, the evaluation typically determines the lowest activation energy for the material and uses this value in the Arrhenius equation. Values greater than the lowest activation energy may be used but a basis for this is to be provided in the applicable EQ binder.

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This conservative approach is, in fact, applied in the example cited by the staff in its question utilizing an activation energy of 0.85 eV (the lowest listed) to calculate a qualified life of 68.14 years.

TVA notes that each EQ binder is to identify the activation energy used in calculating the qualified life of the item and to provide a reference to the source of the activation energy. This reference is typically provided in lists in Section H of Tab B, but in some cases where multiple materials are involved or other detailed discussion are required, the activation energies used and reference(s) are provided in Tab C.

The methods utilized at WBN for determining activation energy for use in the Arrhenius equation is in line with standard industry practice and industry data which is available. The application of the data results in a conservative qualified life.

Additional Topics

A review of the areas of interest in Enclosures 2 and 3 identified several issues related to submergence for which the generic input below is provided:

Submergence is a specific topic in the EQ checksheet, Tab B, to be addressed. In certain instances additional input is presented in Tab C of the EQ binder. The basis for determining if a device is subject to submergence is field walkdown data to provide equipment elevation and conduit located below potential submergence levels. The potential submergence levels due to high energy line breaks (HELB) are provided on the Environmental Data Drawings.

For cables, acceptance of qualification considering submergence is premised on one of the following:

a. Cable is installed in such a manner that precludes its submergence,

b. Cable performs its safety function prior to being submerged, and

c. Cable failure due to submergence will not result in impact on event mitigation or provide misleading information to the operator.

For cables subject to submergence, the applicable EQ binder provides a discussion on the acceptance of the cable or currently delineates an open item for the cable to be relocated or otherwise protected from submergence.

For equipment, submergence is evaluated in a fashion similar to cable with the exception that certain components have documentation in the EQ binder qualifying the item for the submerged case.

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Response To RAI Enclosure 1 - General Information

Information related to submergence for individual components will be available in the EQ binders for WBN Unit 1 during the onsite inspection.

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ENCLOSURE 2
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (RAI) ENCLOSURE 2 CONCERNING ENVIRONMENTAL QUALIFICATION (EQ) SPECIAL PROGRAM

Note: Based on discussion with the NRC reviewers, questions in Enclosure 2 have been modified as more specifics were given through meetings and telephone conversations as discussed in the cover letter.

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Response to RAI Enclosure 2 - EQ Cable Binders (CABL-XXX)

All questions related to the cable binders that were noted in RAI Enclosure 2 are addressed generically in the responses set forth in Enclosure 1 (answers to RAI Enclosure 1 questions).

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Response to RAI Enclosure 2 - Binder WBNEQ-ILP-001 - Comsip Delphi Hydrogen Analyzers

The NRC reviewer questioned a statement in EQ Binder ILP-001 which said the tested unit was installed in Unit 2 after being refurbished.

These units are not required for Unit 1 operation, and there are currently no plans to install the tested components in Unit 2. The referenced statement is not relevant to WBN's Unit 1 EQ Program and has been identified for deletion from the binder.

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Response to RAI Enclosure 2 - EQ Binders WBNEQ-ITE-001, WBNEQ-ITE-003, and WBNEQ-ITE-004 - Resistance Temperature Detectors (RTDs)

The NRC reviewer questioned submergence.

Submergence is addressed generically in Enclosure 1.

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Response to RAI Enclosure 2 - Binder WBNEQ-ITS-001 - Fenwal Temperature Switches

The NRC reviewer questioned whether plant normal radiation should be provided in EQ Binder ITS-001, Tab B, Section H(5)d.

The EQ binders include Tab B, Section H (Aging) which deals with all aspects of aging, including radiation.

Regarding the specific components, plant normal radiation is specified in Tab B, Section H(5)c as being less than 5 X 10^4 rads (total integrated dose). Therefore, these switches were exempted from radiation exposure during qualification testing. Plant normal radiation value was the only value applicable to this question and since it was previously presented in (5)c, repeating the information in H(5)d was redundant.

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Response to RAI Enclosure 2 - Binder WBNEQ-IZS-001 - Namco Model EA180 Limit Switches

The NRC questioned how the peak temperature (453°F) during a Main Steam Line Break (MSLB) in steam valve rooms was addressed with respect to the maximum demonstrated temperature (391°F).

The subject EQ binder contained, in Tab C, a writeup addressing qualification of the devices in the Steam Valve Vault Rooms for a MSLB. The writeup at the time of the submittal was based on a safety evaluation which addressed operating times occurring before the peak temperature and consequences due to failures after the peak temperature. This method of addressing MSLB in the valve vaults for qualification is no longer being utilized. The following activities have occurred since the information was transmitted: a) Calculations have been performed to more accurately model the environmental effects of a MSLB in the valve vaults with a subsequent reduction in the peak temperatures; b) thermal lag calculation has been completed for limit switches and the results incorporated into the binder (see attached excerpt from Tab C of EQ Binder IZS-001).

BINDER NO. WBNEQ-IZS-001	PLANT WBN	UNIT(S) 1	SHEET 1 OF 1 R 2 R 6
BINDER TITLE EA 180 Series Limit Switches Manufactured After 7/30/80	COMPUTED DRS	DATE 6/26/86 JDH 12/11/89	6/19/92
	CHECKED RNB	DATE 6/27/86 WCG 12/14/89	RM 6/19/92

ACCIDENT SIMULATION AND POST ACCIDENT DEGRADATION EQUIVALENCY - (TAB B SECTION L)

WBNOSG4-152 concludes that for NAMCO Model No. EA-180, the peak temperature for a MSLB in the valve vault based on thermal lag is 316°F. During the test, the chamber temperature was kept at 345°F for four hours and is therefore bounding. R6

Using Arrhenius Methodology as documented in the attached calculation report (WBNAPS2-085), the heat aging applied to the limit switches during the simulation exceeds the aging that would result from the DBE and post-accident operating time of 100 day with a conservatism factor of 478.44 percent. R6

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Response to RAI Enclosure 2 - Binder WBNEQ-MOT-001 - Westinghouse Large Electric Induction Motors

The NRC reviewer questioned the specified and demonstrated temperatures shown under Section L(1) of Tab B - Comparison of Worst Case Maximum Parameters.

The subject EQ binder contains, in Tab C, a discussion of qualification of Westinghouse medium voltage motors. Briefly, Section 5-6 of Westinghouse test report WCAP 8687 (EQ Binder MOT-001) indicates that the test motor stator was subjected to a 100 percent relative humidity at 35°C (95°F) for 48 hours. However, the TVA motors are not subject to this condition. The TVA motors are only subject to design base event (DBE) radiation exposure with no appreciable increase in temperature, pressure, or humidity. Therefore, qualification is based on normal condition, including anticipated operational occurrences and radiation exposure from LOCA. As per Section 5.2 of the proprietary test report (WCAP-8687, Supplement 2 - A02A), the test motor stator was thermally aged for 168 hours at 210°C (410°F) which envelopes the maximum ambient 110°F.

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Response to RAI Enclosure 2 - Binder WBNEQ-MOT-002 - Reliance Electric Induction Motors With Type RH Insulation

The NRC reviewer questioned why TAB B, Section 0, question 10 (b) concerning chemical spray was checked "No."

The subject EQ binder contains, in Tab C, a discussion of suitability of chemical spray conditions. Therefore this question should have been answered "Yes."

Attached is a copy of the binder, Tab C, discussion of chemical spray with respect to Reliance motors.

#13 (Enclosure 2)

BINDER NO. WBNEQ-MOT-002 PLANT WBN	UNIT(S) 1		SHEET 10 OF 16 R 2 R
BINDER TITLE INDUCTION MOTOR-TYPE RN INSULATION-INSIDE CONTAINMENT	COMPUTED RSR	DATE 6/9/86 JDH 1-18-89	
	CHECKED WBK	DATE 6/12/86 KBN 1/18/89	

4.3.2 Suitability of Chemcial Spray Conditions

The chemical composition of the initial solution used by Joy on a per liter basis is as follows in accordance with Table A1 of Appendix A to IEEE 323-1974, Qualifying Class 1E Equipment:

600 ml potable water
0.28 molar H_3BO_3 (3000 ppm Boron)
NaOH (about .59%)
0.064 molar $Na_2S_2O_3$
As needed, water & NaOH to make-up total of one liter volume at required pH

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The spray solution used at Watts Bar has the following composition:

0.19 molar H_3BO_3 (2000 ppm Boron) |R2
0.033 molar NaOH

The pH of the Joy solution is 10.5 as opposed to the pH of 8.3 of the solution used at Watts Bar. As indicated in the |R2 TVA memorandum to R. A. Sessoms from John A. Raulston dated November 1, 1985 (B45 851101 255), the solution specified in IEEE 323 is less stable and more corrosive than the alkaline borate solution with a pH of 8.2 used at Sequoyah. The difference in pH between Sequoyah and Watts Bar is insignificant; therefore, the Joy solution is also less stable and more corrosive than the solution used at Watts Bar. The flow rate at Watts Bar is greater than the test flow |R2 (0.92 vs. 0.15 gpm/ft^2); however, the effect is insignificant due to the use of the harsher solution.

At Watts Bar the duration of the spray is less than or equal |R2 to 30 days, while spray in the Joy test was stopped after 7 days. The adverse effects caused by the corrosive sprays would be worse without the surface flushing action that is the result of forceful continuous spray and therefore, the chemical spray introduced into the pressure vessel during the Joy test is at least as severe as the actual chemical spray conditions postulated for Watts Bar. |R2

4.3.3 Anomalies

Minor interruptions were experienced during the 10,145 hours of post-DBE operation. Two occurrences were of some significance and both were addressed in the Joy report. The

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Response to RAI Enclosure 2 - Binder WBNEQ-MOT-004 - Louis Allis Electric Squirrel Cage Induction Motors

The NRC reviewer questioned Note 1 under Section L(1) and L(3) of Tab B concerning the specified and demonstrated operating time and temperature.

The EQ Program provides for the review of qualified life calculations through guidance given in the generic EQ Binder GEN-001.

Regarding the specific motors in this question, the subject EQ binder contains in Tabs C and D, a detailed discussion of Louis-Allis NH7 insulation system qualification and qualified life calculations. The results of qualified life calculations support the conclusion that the demonstrated operating time and temperature conservatively envelope the specified operating time and temperature.

Attached is the appropriate sections of the EQ binder Tab C discussion of qualified life with respect to Louis-Allis motors (EQ Binder MOT-004).

An analysis of this data results in the following maximum brake horsepower requirements for each of the three motor insulation systems:

3 hp, NH5 system - 66.67%
3 hp, NH7 system - 70%
3 hp, NH9 system - 58.33%

The fan inertias and the fan speed in rpm are listed in Appendix A of the contract specification. A review of this data indicates that the load inertia reflected to the motor shaft is much less than the maximum permissible inertia values listed in NEMA MG 1-12.50. It is obvious, therefore, that the new motors have more than adequate capability to accelerate the load inertia.

The replacement motors are NEMA design B as were the motors that they replaced. The replacement motors and the original motors have comparable torque characteristics. The replacement motors are conservatively oversized, thus, no torque deficiency is anticipated.

3.0 Qualification Methodology

3.1 General Discussion

Qualification of motors manufactured by Louis Allis is established through the use of analysis combined with partial aging test data that supports the analytical assumptions used and the conclusions that are drawn. The partial type test data utilized in the analysis was developed in accordance with the requirements contained in Section 5.0, Normal Service Qualification Tests, of IEEE Std. 334-1974, Type Tests of Continuous Duty Class 1E Motors. Of particular importance is the development of an implied average life characteristic for any of the given Louis Allis insulation systems. The life characteristic establishes an expected qualified life in hours for any given total operating temperature. Data used to develop the life characteristic was obtained in accordance with the methods of IEEE Std. 117-1974, Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery. The purpose of this procedure is to classify insulation systems in accordance with their temperature limits established by test data rather than chemical composition. This test data permits subsequent comparisons relative to previously established limits of known systems. The procedure involves submitting models of stator insulation systems called motorettes to a series of exposures to heat, vibration, moisture, and electrical stresses to which the representative motor may be subjected. The series of exposures is intended to represent the effects of long-term service, under accelerated conditions.

Because the motorettes are only models of an insulation system, they do not include bearing or rotor assemblies and therefore, actual operation as a motor was not effected. Paragraph 4.1 of IEEE 334-1974 states that test procedures to demonstrate adequacy for the required Class 1E functions requires a knowledge of motor construction and the particular features upon which expected performance depends. Induction motors are devices which operate upon relatively basic principles. An induction motor is simply an electric transformer whose magnetic circuit is separated by an air gap into two portions capable of relative motion. Alternating current is supplied to the primary or stator winding which induces an opposing current in the secondary or rotor winding. In a squirrel-cage induction motor, the rotor winding consists of metal or metal-alloy bars that are short circuited on both ends. Rotation is the result of the interaction of the magnetic fields created by the currents in each of the windings.

In the induction motor, rotor current, and the subsequent rotation, is established solely by the principle of induction and is thereby wholly dependent upon the electromagnetic field created by the stator winding as a result of the current passing through that winding. The degradation and subsequent loss of the dielectric properties of the stator insulation system, primarily with regards to the ground-wall insulation, but including the motor leads, would result in the loss of current in the stator winding. Many of the components typically used in stator insulation systems are organic materials and therefore are susceptible to the effects of environment and voltage and mechanical stresses. The effect of aging on these materials must be addressed by test and/or analysis.

Because the rotor winding consists of metal bars, short-circuited together, this winding will generally fail in an open-circuit manner. However, the failure of a limited number of rotor bars would not prevent motor operation. Rather, it would degrade motor performance with regards to torque developed. Motor vibration would also increase. A surveillance program incorporating periodic vibration analysis will detect this potential mode of failure. Refer to TAB G.

Industry experience has indicated that a majority of motor failures can be attributed to failures of the lubrication-bearing-seal system rather than through a failure of the stator insulation system. The effect of aging on this system is also addressed. Refer to Section 4.0 of TAB C.

A third possible mode of failure can be manifested in a loss of mechanical strength properties of the rotor shaft or stator support assemblies. Materials used in these assemblies are typically inorganic in nature and are not adversely affected by moderate elevated temperatures. Irradiation also does not affect this property in inorganic materials. A loss of mechanical strength could occur over an extended period of time as a result of the assembly being repeatedly subjected to vibrational stresses. A surveillance program incorporating periodic vibration analysis will detect this potential mode of failure so that subsequent corrective action can be taken. Refer to TAB G.

The procedures given in IEEE 117 are designed to simulate the cumulative effects, due to operation, upon components that are subjected to degradation due to aging. The effect of operational wear and tear on the stator insulation system, due primarily to operating temperature, humidity, and vibration, are simulated in the motorette tests and are reflected in the development of an implied average life characteristic. The intent in the development of this characteristic is to encompass applications in a wide range of ambient environmental conditions. Where the effect of a DBE upon ambient environmental conditions is minimal, the effects of DBE and post-DBE exposures upon the motor stator insulation system can be considered to be reflected in the implied average life characteristic and a separate accounting for these effects is not required.

The ability of a motor to perform as designed is determined by comparison of calculated design data with data taken from a series of commercial tests that is conducted upon the motor prior to shipping.

3.2 General Test Sequence

The test sequence prescribed by IEEE 117-1974 is listed below and was generally adhered to by Louis Allis, except in those instances where justifiable deviations were deemed necessary. The specifics regarding the testing and the subsequent determination of qualified life for the Louis Allis NH5, NH7, and NH9 insulation systems can be found in Attachments 1, 2, and 3, respectively.

1. Construct motorettes to model the motor stator insulation system.

2. Verify the adequacy of the motorettes through baseline testing of insulation resistance and voltage checks. Inspection of the equipment for damage prior to conducting this testing is not required because any significant damage would result in a failure of this test.

3. Determine the ability of the insulation system to withstand radiation.

4. Following irradiation, submit motorettes to each of 3 different temperatures for duration to be determined in accordance with Table 1 of IEEE 117.

5. After each heat cycle, submit each set of motorettes to periods of mechanical stressing by vibration testing, to simulate the effect of normal radial end winding forces in an actual motor. (Note: Seismic qualification was established via analysis and is outside the scope of this program.)

6. Expose motorettes to an atmosphere of 100% relative humidity for a period of 48 hours to allow a visible, uniform condensation to form on the motorette windings.

7. Immediately following step 6 above and while the motorettes are still wet, perform dielectric proof tests.

8. Repeat steps 4 through 7 for each of the motorettes which passes the dielectric tests until all motorettes fail.

9. Develop implied average life characteristic for the insulation system using procedures in IEEE 101-1972, Statistical Analysis of Thermal Life Test Data.

10. The Lubricant-Bearing-Seal system is designed in accordance with data provided in standards from the Anti-Friction Bearing Manufacturers Association (AFBMA). This data is based upon industry standard tests and serves as the basis for the qualification of this type of bearing. This data is also used to establish required maintenance schedules. Refer to TAB C, Section 4.0.

11. The motor assembly is analyzed for the presence of any organic materials that may contribute either directly or indirectly to a motor failure due to an aging-related phenomenon. These materials must either not degrade the qualified life of the motor or be identified as components requiring periodic replacement.

3.3 DBE and Post-DBE Exposure Analysis

As indicated in Section 3.1, the intent in the development of an implied average life characteristic is to encompass a variety of applications occurring in a wide range of ambient environmental conditions including DBE conditions.

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Response to RAI Enclosure 2 - Binder WBNEQ-MOV-001 - Limitorque Motorized Valve Actuators

The NRC reviewer questioned the following items:

(1) Why is the demonstrated temperature (315°F) less than the specified temperature (327°F) in Tab B, Section L(1)?
(2) Explain specified submergence (Tab C, Item 13.0).

As discussed below, the EQ Program addresses such concerns and, in fact, the relevant information is included in the EQ binder.

Regarding the specific concerns for the identified binder, the following information is provided:

(1) The difference in the temperatures is addressed in Tab C, Section 7.2, as stated in the note at bottom of Page B-24. Essentially the basis is the thermal lag between the heavy mass of the Limitorque operator and the superheat steam. Attached is a copy of Tab C, Section 7.2 for your information.
(2) Tab C provides an evaluation of device elevation versus flood level and concludes that none of the devices in this binder are subject to submergence for events requiring the device to function.

7.2 Accident Simulation

By observation the test profile does not envelop the peak WBN postulated temperature; the difference is approximately 27°F, including 15°F martin, for approximately 17 minutes. We conclude the temperature difference and duration do not disquality the actuator for the following reasons: Limitorque report No. B0027 documents testing performed on an Limitorque actuator during superheated steam exposure with ambient (test chamber) conditions to 385°F. Due to the terminal mass of the actuator, and the instability of super-heated steam, the temperature of the internals, limit and torque switches, etc., did not exceed saturated steam temperature (315°F). The Watts Bar temperature profile peaks at 327°F at a maximum pressure of 26.4 psi. At 26.4 psi the saturation temperature is 244°F. As stated in report No. B0027, until the mass of the actuator can be brought to saturation temperature, steam at a temperature greater than the saturation temperature will condense since the temperature of the actuator will not support it. When we combine the decreasing Watts Bar temperature and pressure transients with the lag that occurs while the actuator is brought up to saturated steam pressure temperature, we conclude that the 12 F temperature difference for 17 minutes is not significant in comparing the two test profiles due to the thermal lag caused by the actuator mass. Thus, we conclude from the thermal mass assessment, the demonstrated testing and aging calculation (WAC-360) that the WBN actuators are qualified for an expected 40 year plant life plus 100 days of post-accident operation. |R5

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Response to RAI Enclosure 2 - Binder WBNEQ-SOL-001 - Target Rock Solenoid Operated Valves

The NRC reviewer posed questions regarding the following items: (1) Was the new linear voltage differential transformer (LVDT) aged? (page B-9), and (2) operability requirement (page B-28, Item 4).

As discussed below, the TVA WBN EQ Program addressed such concerns and, the relevant information is included in the EQ binder.

Institute of Electrical and Electronic Engineers (IEEE) 323-1974 provides for the qualification of Class 1E equipment by testing and analysis.

Regarding the specific component addressed by this questions, the subject Binder SOL-001 contains Westinghouse Qualification Report WCAP-8687, Supplement 2 - H10C R1 (proprietary), which provides justification, in Section 6.9, by analysis for not using an aged LVDT in the high energy line break (HELB) test. Therefore, the test was completed using an un-aged new LVDT. Regarding the operability requirements, the qualification test itself did not envelope the WBN conditions; however, an analysis in Tab C-2 provides justification by referencing additional Target Rock testing.

Attached as an example are the applicable pages from Tab C in EQ Binder SOL-001 which discuss why the new LVDT was not aged, and also the post-accident operability referenced in Tab B.

BINDER NO. WBNEQ-SOL-001	PLANT WBN	UNIT(S) 1	SHEET 1 OF 3
			R 1 R
BINDER TITLE SOLENOID VALVES TARGET ROCK - MODELS 79AB-001 AND 79AB-003	COMPUTED RJP	DATE 9/12/86	2/23/89
	CHECKED RKW	DATE 9/12/86	3/21/89

POST-ACCIDENT OPERABILITY

OE Calculation WBN-OSG4-045 states that under accident conditions, the valves listed in this binder are energized as follows: R1

(1) During a LOCA or breaks in the Main Steam or Feedwater lines inside containment, these valves are energized for the first 15 minutes of the accident, then must be capable of cycling 1 time per day at a duration of 1 minute per cycle for the remaining 100 day duration of the event.

(2) During breaks in either the RHR or CVCS lines inside containment, these valves are energized for the first 15 minutes of the accident then must be capable of cycling 1 time per day at a duration of 1 minute per cycle for the remaining 31 day duration of the event.

As shown above, the valves in this binder are energized a maximum of 15 minutes at the beginning of any DBE. To satisfy the margin as outlined by IEEE-323(74), 1 hour will be added to the energized time of 15 minutes required for the initial accident conditions. This equates to a conservative total energized time of 75 minutes, at the start of the accident, for which coil heat rise must be accounted.

Due to the fact that during energized conditions the coil is the hottest component of a solenoid valve, in all post-accident calculations the coil will be used as the limiting component of the valves in this binder.

Since Westinghouse did not energize the test valves for any sustained amount of time during their DBA simulations, the coil temperature must be determined during the Watts Bar postulated accident to evaluate the Westinghouse DBA simulation tests. Target Rock Test Report No. 4207 (Attachment 2) shows that at an ambient temperature of 73°F a thermally stabilized solenoid coil experiences a 212°F temperature rise. As shown in Attachment 3, Target Rock did a high ambient temperature test to verify valve operation at temperatures associated with high energy steam line breaks. The test consisted of installing a DC powered ASME Section III solenoid valve, Design Drawing Number 1032110-4 which is the same as the Model 79AB-001 valves in this binder, in a test chamber and allowing the chamber to reach a steady state temperature of 400°F. After chamber temperature stabilization, the test valve was energized open with 125 VDC, allowing 1000 psig 544°F steam to flow through the valve. The valve remained energized continuously under these conditions for 1 hour at which time the test was considered complete. Temperatures obtained from averaging points 3 and 4, at the top and base of the solenoid as shown on Sheet 5 of attachment 3, plotted against their associated times, shows that at the end of the 1 hour energization time the solenoid coil was at an essentially steady state temperature.

Using data from the Target Rock high temperature test (Attachment 3) from times 10:51 to 11:51, a solenoid coil temperature rise of 70°F at a 405°F ambient is calculated.

Since solenoid coil temperature rise (T) is a decreasing function of ambient temperature, linear interpolation between data points (73°F, T = 212°F) and (405°F, T=70°F) provides a conservative estimate of the coil steady state temperature rise at 327°F, i.e., the maximum postulated accident temperature inside containment at Watts Bar. This temperature rise is calculated as 103°F, and since it is unknown how quickly a solenoid coil reaches its maximum temperature during energization, in the attached post-accident life calculations an instantaneous coil heat rise of 103°F was added to the accident temperature profile for the first 75 minutes. Using this methodology, the accident degradation equivalency calculations show that the Westinghouse LOCA simulation tests envelop the Watts Bar post-accident requirement by 1849 percent for the Model 79AB-001 valve and 1634 percent for the Model 79AB-003 valve. However, the attached graphic representation of the accident simulation versus the accident requirement shows that the Westinghouse tests for the valves in this binder do not entirely envelop the Watts Bar temperature requirement during the initial valve energization time using the parameters stated above. R2

As graphed and shown in the attached aging calculation, the Target Rock Main Steam Test (Project 79L, prototype 1032110-4, Attachment 3) more than adequately envelops the initial energization time and has proven that the aforementioned test is more severe than Watts Bar's required accident temperature profile. The Target Rock test had a continuous 400°F temperature at which the valve was energized for 1 hour with 544°F steam flowing through the valve. In order to utilize Target Rock's test it must be taken into consideration that under normal plant operation the valves in this binder would be cycled a maximum of 800 times at less than 1 minute per cycle (see TAB C, Section C-1 for normal cycling). Also, during the initial 75 minutes of a LOCA the total beta/gamma radiation dose is 6.4 x 10^6 rads[1], which added to the 40 year TID of 2 x 10^7 rads is insignificant relative to the valve materials as demonstrated during radiation testing of these Target Rock valves. In addition, TAB C, Section C-1 requires all valve elastomers to be replaced every 10 years, which will drastically reduce the accumulated radiation dose for these components, and TAB G requires checking the coil and position switch insulation for excessive degradation anytime a valve is disassembled for any reason. This suggests that at the end of 40 year plant life all valve components would be in excellent if not like-new condition just as the Target Rock test valve was before high temperature testing. R2

[1]Per OE Calculation WBNNAL3-004, OE Calculation TI-RPS-48, and DNE Calculation WBNTSR-051. R2

BINDER NO. WBNEQ-SOL-001	PLANT WBN	UNIT(S) 1	SHEET 3 OF 3				
BINDER TITLE SOLENOID VALVES - TARGET ROCK - MODELS 79AB-001 AND 79AB-003		COMPUTED RJP	DATE 7/7/86	R 2 GJM 8/24/90	R		
		CHECKED GS	DATE 7/8/86	CSH 8/24/90			

Since the valves in this binder are energized such a short period of time (15 minutes), flowing medium temperature is not a concern due to the thermal lag characteristics demonstrated by the valve as tested above. In the Target Rock test above 1000 psig 544°F steam flowed through the test valve and the valve continued to perform its intended function without any problems.

Due to the above, it is safe to conclude that the 15 minutes of energization at the beginning of any DBE will not have a degrading effect on the valves in this binder.

ACCIDENT VOLTAGE VS. OPERATION

THE 125V DC VOLTAGE ANALYSIS IN CALCULATION WBN-EEB-MS-TI11-0004 USES A WORST CASE CIRCUIT BASED ON THE LONGEST CIRCUIT PATH, AND MAXIMUM LOAD DEMAND. THE SOLENOID VALVE ANALYZED TO OBTAIN THE 84.37 V DC MINIMUM WAS RATED 3.5 AMPS AT 125V DC. HOWEVER, THE MAXIMUM LOAD FOR THE VALVES IN THIS BINDER IS 1.0 AMP WHICH MAKES THE RESISTANCE BE 125 OHMS. INSERTING THIS RESISTANCE VALUE INTO THE CALCULATION ON PAGE D7 OF WBN-EEB-MS-TI11-0004 GIVES A MINIMUM VOLTAGE OF 97.48V DC DURING ACCIDENT CONDITIONS. SINCE THE VALVES WERE TESTED AT 90 V DC DURING HELB SIMULATION, THIS PROVES OPERABILITY DURING ACCIDENT CONDITIONS. R2

POST-ACCIDENT CYCLING (Worst Case)

During a LOCA, the valves in this binder are required, after their initial 15 minute energization, to cycle 100 times at 1 minute per cycle over the 100 day duration of the accident. Westinghouse demonstrated that the Target Rock valves contained in this binder would continue to perform their function during and after a DBA. After the LOCA simulation, the valves were disassembled and inspected. No evidence was found to suggest that the valves would not continue to perform their intended function, i.e., visual inspection showed no functional deterent degradation and performance tests taken during and after the test did not significantly vary from baseline tests.

CONCLUSION

Based on the data and analysis presented in this section, it is safe to conclude that the valves in this binder are qualified to perform their safety function throughout any postulated accident scenario required for Watts Bar Nuclear Plant.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binders WBNEQ-SOL-003 & WBNEQ-SOL-005 - ASCO Solenoid Operated Valves (Model Nos. 206-380 & 206-381)

The NRC reviewer questioned the following items:

(1) Operating Time - Page B-24, Item L (Spec. 100 day, Demo. 30 days)

(2) Viton elastomers are only qualified to 2 X 10^7 rads. Section I lists Viton as being used for seats and Section L(1) shows the specified radiation dose greater than 2 X 10^7 rads.

As discussed below, the EQ Program addresses such concerns and, the relevant information is included in the EQ binders.

Regarding the specific concerns for the identified binders the following information is provided:

(1) See response to Question 2 for SOL-002. The method of analysis to justify the 100 day operating time is the same.

(2) The Viton seats are only used on valves in areas with a total radiation dose less than 2 X 10^7 rads. The valves with Viton seats are identified in Tab C along with the associated radiation dose for the environmental area to show that the actual dose to the Viton seats is less than 2 X 10^7 rads. The specified dose in Section L(1) is the maximum for any solenoid valve in the binder (including those with and those without Viton seats).

Attached is an example of one particular environmental area which shows the valves with Viton seats. A specific location radiation calculation WBNNAL3-007 was prepared for this area to show that the total dose is less than 2 X 10^7 rads.

Group A Valves

EQIS No.	Valve Identification No.	Model No. (VITON)
WBN-1-FSV-030-0146A-A	1-FSV-30-146A	206-380-2RVU
WBN-1-FSV-030-0146B-A	1-FSV-30-146B	206-380-2RVU
WBN-2-FSV-030-0157A-B	2-FSV-30-157A	206-380-2RVU
WBN-2-FSV-030-0157B-B	2-FSV-30-157B	206-380-2RVU

System 30 - Ventilation

The system 30 valves are located on the inboard and outboard side of the ABGTS unit. They are normally deenergized and are required to energize to open the associated flow control operators, and must remain energized as long as the ABGTS fan is operating. In addition, they must remain operable for 100 days following a LOCA.

Environmental Parameters (per 47E235-48)

	Normal (Maximum)	Abnormal (Maximum)	Accident (LOCA)
Temperature	104°F	[1]110°F	[2]110°F
Pressure	ATM(-)	ATM(-)	N/A
Humidity	80%	[1]90%	N/A
[5]Radiation	8.8×10^5 rads, gamma	N/A	1.2×10^6 rads, gamma
[3]Chemical Spray	N/A	N/A	N/A
[4]Submergence	N/A	N/A	N/A

[1]Expected to occur 8 hours per excursion and less than 1 percent of plant life.
[2]Lasts for a period of 30 days.
[3]This equipment is located outside primary containment and is not subject to containment spray.
[4]This equipment is located in the ABGTS room and is not subject to submersible conditions.
[5]These valves contain Viton elastomers which are qualifiable only to a radiation dose of 2×10^7 rads, gamma. The LOCA dose is the worst for the four valves listed (See TVA Calculation WBNNAL3007). These valves are located outside containment and are not subject to a beta radiation contribution to the total accident dose. |R2

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binder WBNEQ-SOL-004 - Gould Allied Main Steam Isolation Valve Air Manifold Assembly

The NRC reviewer questioned that the qualified life and replacement interval were not clearly determinable (See Pages B-10, B-15)

As discussed below, the EQ Program addresses such concerns and, the relevant information is included in the EQ binder.

The EQ Program provides for calculation of qualified life and thus replacement intervals in accordance with the analytical process described in generic EQ Binder GEN-001.

Regarding the specific concern, the 10 year qualified life on Page B-10 is based on meeting environmental parameters as stated in the test report which are different from the WBN application. The qualified life based on the WBN specific environmental parameters is calculated in Tab C, subsections C4A-C4C, which is the 12 year (energized) and 40 year (deenergized) stated on Page B-15. The replacement interval is stated in Tab G, "Qualification Maintenance Data Sheet (QMDS)," for each device and is based on the 12 year and 40 year calculated values.

Attached are the pages from WBNEQ-SOL-004 which shows the method for calculating the qualified life based on the aging time and temperature in the test report.

MATERIAL AGING CALCULATION REPORT

TRANSMITTAL

DATE: March 18, 1986

TO: Robert Loveday

FROM: Thomas R. Witmer

BINDER NUMBER: WBNEQ-SOL-004

CALCULATION NO.: WAC-37

INFORMATION ONLY

The attached Material Aging Calculation Report was performed using the System 1000. The System 1000 material aging data base and computer software programs were compiled, written and verified in accordance with Digital Engineering Quality Assurance Program and Operating Procedures and were verified and determined to be acceptable for TVA use by Thomas R. Witmer's memorandum to the Evironmental Qualification Project files dated September 25, 1985 (B70850925013).

This calculation includes two sheets labeled "ENVIRONMENTAL QUALIFICATION PROJECT CALCULATIONS PERFORMED BY THE SYSTEM 1000" plus the following calculation sheets:

WAC-37 CALCULATIONS 1 THRU 13

Performed By: Thomas R Witmer Date: 3/18/86

Verified By: Dottie M Meese Date: 3/18/86

FORM NUMBER: EQTF-005-85
(3-86)

ENVIRONMENTAL QUALIFICATION PROJECT CALCULATIONS

PERFORMED BY THE SYSTEM 1000

All material aging calculations performed using the System 1000 are based on the Arrhenius Model. Derivations of the Arrhenius Equations, along with definitions of the various parameters are:

Expected Life

$$\ln(\text{life}) = (Ea/k_B)(1/T) + \text{Constant} \qquad (1)$$

Qualified Life (Single Service Temperature)

$$t_2 = t_1 / \exp((Ea/k_B)(1/T_1 - 1/T_2)) \qquad (2)$$

Qualified Life (Multiple Service Temperatures)

$$t_2 = t_1 / \sum_{x=2}^{n+1} P_x \exp((Ea/k_B)(1/T_1 - 1/T_x)) \qquad (3)$$

Degradation Equivalency Analysis

$$t_A = \sum_{y=1}^{n} t_y / \exp((Ea/k_B)(1/T_y - 1/T_A)) \qquad (4)$$

where:

$\ln(\text{life})$ = Expected Life (hours)

Ea/k_B = Slope (Activation energy/Boltzmans' Constant)

T = Temperature (Degrees Kelvin)

Constant = Intercept

t_2 = Qualified Life (hours)

t_1 = Aging Time (hours)

exp = exponent to base e

T_1 = Aging temperature (K)

T_2 = Service temperature (K)

P_x = Fraction of 40-year life at T_x

T_x = Service Temperatures (K)

t_A = Equivalent Time at T_A (hours)

t_y = Time at Temperature T_y (hours)

T_y = Accident Test Temperature(s) (K)

T_A = Baseline Temperature (K)

INFORMATION ONLY

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASED ON ARRHENIUS PARAMETERS.

....

TEST 1

ACTIVATION ENERGY (eV) 1.16
AGING TIME (HOURS) 2407
AGING TEMPERATURE (C) .... 158 {120C + 38C COIL RISE
SERVICE TEMPERATURE (C) .... 112 {MAX NORMAL + COIL RISE

QUALIFIED LIFE (YEARS) 11.47

....

TEST 2

ACTIVATION ENERGY (eV) 1.16
AGING TIME (HOURS) 95
AGING TEMPERATURE (C) .... 163 {125C + 38C COIL RISE
SERVICE TEMPERATURE (C) .... 112 {MAX NORMAL + COIL RISE

QUALIFIED LIFE (YEARS) .... .65

....

TEST 1 + TEST 2 QUALIFIED LIFE= 12.12 YEARS

....

BINDER NO. WBNEQ-SOL-004
COIL ENERGIZED + 57.56C RISE
VITON E60C WITHOUT PARKER SUPER-O-LUBE
WAC-37
5

INFORMATION ONLY

IS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASED ON ARRHENIUS PARAMETERS.

ACTIVATION ENERGY (eV)	1.16
AGING TIME (HOURS)	1191
AGING TEMPERATURE (C)	158 (120C + 38C COIL RISE
SERVICE TEMPERATURE (C)	71.44 (MAX NORMAL + COIL RISE
QUALIFIED LIFE (YEARS)	348.57

BINDER NO. WBNEQ-SOL-004
COIL DEENERGIZED + 17C RISE
VITON E60C
WAC-37
4

INFORMATION ONLY

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binder WBNEQ-SOL-006 - ASCO Solenoid Valve Model No. NP8316

The NRC reviewer questioned the following items:

(1) Explain why Page B-17 shows Viton being used and Page B-20 and B-24 shows radiation doses as high as 8.52 X 10^7 rads when Viton is only qualified to 2 X 10^7 rads.

(2) Need more information regarding submergence addressed on Page B-21.

As discussed below, the EQ Program addresses such concerns and, the relevant information is included in the EQ binder.

Regarding the specific concerns for the identified binder the following information is provided:

(1) There are no valves in EQ Binder SOL-006 with Viton elastomers at this time. However, see "Response to RAI Enclosure 2 - Binder WBNEQ-SOL-003" for a typical method of addressing the radiation dose on Viton to ensure 2 X 10^7 rads is not exceeded.

(2) See generic response on submergence in Enclosure 1.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binder WBNEQ-SPLC-001 - Raychem Heat Shrink Cable Splice (600 VAC or less)

The NRC reviewer questioned the following items:

(1) Submergence addressed on pages B-24, B-25 and B-36.

(2) The peak temperature of 453°F during a Main Steam Line Break (MSLB) in the Steam Valve Vault Rooms shown on page B-37.

As discussed below, the EQ Program addresses such concerns and the relevant information is included in the binder.

Regarding the specific concerns for the identified binder the following information is provided:

(1) See generic response on submergence in Enclosure 1.

(2) The evaluation on page B-37 discusses the temperature (349°F) the splice material would be subjected to as a result of a MSLB in the valve vault. The ambient peak temperature in the valve vaults for the MSLB is 453°F; however, the references noted provide the reduced temperatures as a result of a thermal lag evaluation and are based on the fact that splices are contained internal to junction boxes and other devices.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binder WBNEQ-XMTR-001 - Barton Transmitter Model No. 764

The NRC reviewer questioned the replacement of o-rings and fill oil during testing of Barton transmitters qualified by EQ Binder XMTR-001.

Westinghouse proprietary report WCAP 8687, Supplement 2, EQIR-E03A, Revision 2, Section 5.1 and 7.1, discusses the failure of the o-ring following the initial accelerated thermal aging. Replacement of the o-ring required replacement of the fill oil. Following replacement, the entire units were aged an additional 350 hours at 125°C. This additional aging was sufficient to yield for WBN a qualified life of greater than 40 years.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 2 - Binder WBNEQ-XMTR-004 - Barton Transmitter Model No. 763

The NRC reviewer questioned the replacement of o-rings and fill oil during testing of Barton transmitters, whether any of the transmitters in this binder were located in the Main Steam Valve Vault, and how submergence was addressed.

Westinghouse proprietary report WCAP-8687, Supplement 2-E01A, Revision 2, Section 5.1 and 7.1, discusses the failure of the o-ring following the initial accelerated thermal aging. The replacements were thermally aged. The thermal aging condition for the replacements are considered in establishing the qualified life of the device/piece parts as stated in Tab G of the binder.

Four transmitters qualified by this binder are located in the Main Steam Valve Vault Rooms. They are insulated with a custom designed insulation. Based on thermal lag calculation TI-ANL-198 (Tab C-I), the maximum temperature these transmitters will experience is 258.6°F. [See Reference Tab B, L(2)]. The maximum accident temperature any transmitter qualified by this binder will be exposed to is 326°F (inside Containment) which exceeds the maximum temperature determined by the thermal lag calculation.

Refer to Enclosure 1 for discussion on submergence.

ENCLOSURE 3

RESPONSE TO RAI ENCLOSURE 3

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 1

The NRC reviewer noted the test temperature discrepancy between the reported and calculated values and was concerned that the reported values were too low for thermal aging.

The WBN EQ Program provides generally for the review and assimilation of thermal aging considerations through good engineering practice which is documented in the TVA WBN generic EQ Binder GEN-001.

Regarding the specific non-cable components addressed by this question, Tab C in the subject EQ binders includes qualified life calculations using thermal aging results from the test report for the components at various service temperatures. When a component which has less than 40-year qualified life approaches the end of its qualified life, it must be replaced or refurbished. Complete refurbishment requirements and replacement intervals are given in Tab G, Qualification Maintenance Data Sheets (QMDS),of the subject EQ binders.

Attached is an example of the WBN EQ binder Tabs C and G discussion of thermal aging with respect to NAMCO conduit seal assemblies (EQ Binder CSC-002).

The EQ binders for cable denoted in the question are for Okonite supplied cable. These binders contain a report which provides a discussion of the conservative results of extrapolating Arrhenius plots beyond the temperature where experimental data was collected. The conservatism of Arrhenius modeling is further supported by documented data in the EQ binder from Okonite for actual service installations.

The acceptance of this position by NRC is documented in a letter to TVA from NRC dated December 14, 1990 (excerpts are attached), contained in Tab E of the denoted EQ binders.

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 4 OF 4
			R 1 R
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED KFL	DATE 4/26/90 KFL 2/11/91	
	CHECKED HDR	DATE 4/30/90 EE 2/21/91	

#1 (Enclosure 3)

Material Aging Calculation

The worst-case environmental conditions for areas at Watts Bar Nuclear Plant except for steam valve rooms were utilized in this calculation.

1. Qualified Life - Conduit seal assemblies excluding O-rings, have a qualified life of 40 years. O-rings are qualified for 21.98 years in containment and Boric Acid Evap Package Rooms (page C-7 thru C-10). | R1

2. Accident Requirements - The calculation summary shows that the heat aging applied to the conduit seal assemblies during the simulation (with conservation factors of 78%, 26% and 13%) exceeds the aging that would result from the DBE and post-accident operating time of 100 days (pages C-12 thru C-22). | R1 | R1

INFORMATION ONLY

#1 (1)

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASE ON ARRHENIUS PARAMETERS.

SERVICE TEMPERATURES (CELSIUS) AND
% QUALIFIED LIFE AT TEMPERATURE

B44 '900410 803

SERVICE TEMPERATURE # 1 (C)...	48.89
#1: % OF QUALIFIED LIFE.......	99.00
SERVICE TEMPERATURE # 2 (C)...	54.44
#2: % OF QUALIFIED LIFE.......	1.00
SERVICE TEMPERATURE # 3 (C)...	.00
#3: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 4 (C)...	.00
#4: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 5 (C)...	.00
#5: % OF QUALIFIED LIFE.......	.00

AGING TIME (HOURS)...........	1049.00
AGING TEMPERATURE (C).........	120.00
ACTIVATION ENERGY (eV)........	.8

CALCULATIONS ONLY :

SERVICE TEMP. # 1 (K).........	321.89
SERVICE TEMP. # 2 (K).........	327.44
SERVICE TEMP. # 3 (K).........	273.00
SERVICE TEMP. # 4 (K).........	273.00
SERVICE TEMP. # 5 (K).........	273.00
AGING TEMP. (K)...............	393.00

QUALIFIED LIFE (HOURS)........	192535.20
QUALIFIED LIFE (DAYS)........	8022.30
QUALIFIED LIFE (YEARS)........	21.98

BINDER NO.: SQNEQ-CSC-002
NAMCO EC210-34000 SERIES RECEPTACLE ASSEMBLY
NAMCO EC210-44000 SERIES CONNECTOR ASSEMBLY
MATERIAL: EPDM O-RINGS
TEST REPORT: QTR 145, REV 1, DATED MAY 10, 1985
ENIRONMENTAL DRAWING: 47E235-42, R2, LOWER COMPARTMENT
WAC-299
1

INFORMATION ONLY

(1)

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASE ON ARRHENIUS PARAMETERS.

B44 900410 803

SERVICE TEMPERATURES (CELSIUS) AND % QUALIFIED LIFE AT TEMPERATURE	
SERVICE TEMPERATURE # 1 (C)...	40.00
#1: % OF QUALIFIED LIFE.......	99.00
SERVICE TEMPERATURE # 2 (C)...	43.33
#2: % OF QUALIFIED LIFE.......	1.00
SERVICE TEMPERATURE # 3 (C)...	.00
#3: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 4 (C)...	.00
#4: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 5 (C)...	.00
#5: % OF QUALIFIED LIFE.......	.00
AGING TIME (HOURS)............	1049.00
AGING TEMPERATURE (C)..........	120.00
ACTIVATION ENERGY (eV)........	.8

CALCULATIONS ONLY :

SERVICE TEMP. # 1 (K)..........	313.00
SERVICE TEMP. # 2 (K)..........	316.33
SERVICE TEMP. # 3 (K)..........	273.00
SERVICE TEMP. # 4 (K)..........	273.00
SERVICE TEMP. # 5 (K)..........	273.00
AGING TEMP. (K)...............	393.00
QUALIFIED LIFE (HOURS)........	437945.35
QUALIFIED LIFE (DAYS)........	18247.72
QUALIFIED LIFE (YEARS)........	49.99

BINDER NO.: WBNEQ-CSC-002
NAMCO EC210-34000 SERIES RECEPTACLE ASSEMBLY
NAMCO EC210-44000 SERIES CONNECTOR ASSEMBLY
MATERIAL: EPDM O-RING
TEST REPORT: QTR 145, REV 1, DATED MAY 10, 1985
ENIRONMENTAL DRAWING: 47E235-76, R3 & -85, R1
WAC-299 *outside containment except*
2 *KF 4/24/90*

INFORMATION ONLY

E3-4

PAGE *C-8*

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASE ON ARRHENIUS PARAMETERS.

SERVICE TEMPERATURES (CELSIUS) AND % QUALIFIED LIFE AT TEMPERATURE	B44 '900410 803
SERVICE TEMPERATURE # 1 (C)...	48.89 -120°F
#1: % OF QUALIFIED LIFE.......	99.00
SERVICE TEMPERATURE # 2 (C)...	54.44
#2: % OF QUALIFIED LIFE.......	1.00
SERVICE TEMPERATURE # 3 (C)...	.00
#3: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 4 (C)...	.00
#4: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 5 (C)...	.00
#5: % OF QUALIFIED LIFE.......	.00
AGING TIME (HOURS)............	1049.00
AGING TEMPERATURE (C).........	120.00
ACTIVATION ENERGY (eV)........	1.13

CALCULATIONS ONLY :

SERVICE TEMP. # 1 (K)..........	321.89
SERVICE TEMP. # 2 (K)..........	327.44
SERVICE TEMP. # 3 (K)..........	273.00
SERVICE TEMP. # 4 (K)..........	273.00
SERVICE TEMP. # 5 (K)..........	273.00
AGING TEMP. (K)................	393.00
QUALIFIED LIFE (HOURS)........	1651418.91
QUALIFIED LIFE (DAYS)........	68809.12
QUALIFIED LIFE (YEARS)........	188.52

BINDER NO.: WBNEQ-CSC-002
NAMCO EC210-34000 SERIES RECEPTACLE ASSEMBLY
NAMCO EC210-44000 SERIES CONNECTOR ASSEMBLY
MATERIAL: EPDM/CPSE LEAD WIRE JACKET
TEST REPORT: QTR 145, REV 1, DATED MAY 10, 1985
ENIRONMENTAL DRAWING: 47E235-42, R2, LOWER COMPARTMENT
WAC-299
3

INFORMATION ONLY

(1)

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS
BASE ON ARRHENIUS PARAMETERS.

SERVICE TEMPERATURES (CELSIUS) AND
% QUALIFIED LIFE AT TEMPERATURE

B44 '900410 803

SERVICE TEMPERATURE # 1 (C)...	40.00
#1: % OF QUALIFIED LIFE.......	99.00
SERVICE TEMPERATURE # 2 (C)...	43.33
#2: % OF QUALIFIED LIFE.......	1.00
SERVICE TEMPERATURE # 3 (C)...	.00
#3: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 4 (C)...	.00
#4: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 5 (C)...	.00
#5: % OF QUALIFIED LIFE.......	.00

AGING TIME (HOURS)............	1049.00
AGING TEMPERATURE (C)..........	120.00
ACTIVATION ENERGY (eV).........	1.13

CALCULATIONS ONLY :

SERVICE TEMP. # 1 (K)..........	313.00
SERVICE TEMP. # 2 (K)..........	316.33
SERVICE TEMP. # 3 (K)..........	273.00
SERVICE TEMP. # 4 (K)..........	273.00
SERVICE TEMP. # 5 (K)..........	273.00
AGING TEMP. (K)................	393.00

QUALIFIED LIFE (HOURS)........	5275687.33
QUALIFIED LIFE (DAYS)........	219820.31
QUALIFIED LIFE (YEARS)........	602.25

BINDER NO.: WBNEQ-CSC-002
NAMCO EC210-34000 SERIES RECEPTACLE ASSEMBLY
NAMCO EC210-44000 SERIES CONNECTOR ASSEMBLY
MATERIAL: EPDM/CPSE LEAD WIRE JACKET
TEST REPORT: QTR 145, REV 1, DATED MAY 10, 1985
ENIRONMENTAL DRAWING: 47E235-76, R3 & -85, R1
WAC-299
4

Outside containment except KFL 4/23/90

INFORMATION ONLY

THIS PROGRAM IS DESIGNED TO PERFORM QUALIFIED LIFE CALCULATIONS BASE ON ARRHENIUS PARAMETERS.

SERVICE TEMPERATURES (CELSIUS) AND
% QUALIFIED LIFE AT TEMPERATURE

B44 '900410 803

SERVICE TEMPERATURE # 1 (C)...	48.89
#1: % OF QUALIFIED LIFE.......	99.00
SERVICE TEMPERATURE # 2 (C)...	54.44
#2: % OF QUALIFIED LIFE.......	1.00
SERVICE TEMPERATURE # 3 (C)...	.00
#3: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 4 (C)...	.00
#4: % OF QUALIFIED LIFE.......	.00
SERVICE TEMPERATURE # 5 (C)...	.00
#5: % OF QUALIFIED LIFE.......	.00

AGING TIME (HOURS)............	1000.00
AGING TEMPERATURE (C).........	200.00
ACTIVATION ENERGY (eV)........	.63

CALCULATIONS ONLY :

SERVICE TEMP. # 1 (K).........	321.89
SERVICE TEMP. # 2 (K).........	327.44
SERVICE TEMP. # 3 (K).........	273.00
SERVICE TEMP. # 4 (K).........	273.00
SERVICE TEMP. # 5 (K).........	273.00
AGING TEMP. (K)...............	473.00

QUALIFIED LIFE (HOURS)........	1410235.04
QUALIFIED LIFE (DAYS).........	58759.79
QUALIFIED LIFE (YEARS)........	160.99

BINDER NO.: WBNEQ-CSC-002
MATERIAL: RTV
TEST REPORTS: QTR-145 & QTR-142
ENVIRONMENTAL DRAWING: 47E235-42, R2
WAC-299
5

INFORMATION ONLY

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 1 OF 5
			R / R
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED KFL	DATE 4/27/90 KFL 2/11/91	
	CHECKED HDR	DATE 4/30/90 EEM 2/21/91	

QUALIFICATION MAINTENANCE DATA SHEET (QMDS)

TAB G

1. ESSENTIAL REQUIREMENTS/RECOMMENDATION IDENTIFICATION

EQIS NO.	QUAL LIFE	START OF QL	REFERENCE REQUIREMENTS MAINT.	REFERENCE REQUIREMENTS STORAGE	REFERENCE RECOMMENDATIONS SURV.	REFERENCE RECOMMENDATIONS P.M.
WBN-1-CSC-067-0350-A	40 yrs	See Note	A	B	C	NA
WBN-1-CSC-067-0352-B	40 yrs	See Note	A	B	C	NA
WBN-1-CSC-067-0354-A	40 yrs	See Note	A	B	C	NA
WBN-1-CSC-067-0356-B	40 yrs	See Note	A	B	C	NA
*1-@PL-067-3114-A	40 yrs	See Note	A	B	C	NA
*1-@PL-067-3124-B	40 yrs	See Note	A	B	C	NA
*1-@PL-067-3094-A	40 yrs	See Note	A	B	C	NA
*1-@PL-067-3104-B	40 yrs	See Note	A	B	C	NA

NOTE: Initial Criticality.

* Pigtail of the conduit seal assembly

R1

INFORMATION ONLY

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 2 OF 5
			R 1 R
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED KFL	DATE 4/28/90 KFL 2/21/91	
	CHECKED HDR	DATE 4/30/90 WCT/EEH 2/21/91	

QUALIFICATION MAINTENANCE DATA SHEET (QMDS)

TAB G

A. ESSENTIAL EQUIPMENT MAINTENANCE REQUIREMENTS

1. The conduit seal assembly must be installed per the manufacturers instructions.[1]

2. Replacement of the three o-rings on the EC210-29000 and -44000 series connector/cable assembly is required if the o-rings are damaged during the attachment or separation of the connector and receptacle[2]. Replace the EPDM o-rings for all assemblies located inside containment and Boric Acid Evap Package Rooms every 21.98 years[9]. R1

3. Do not use pipe wrenches, pliers, vice grips, channel locks or similar tools for the assembly of the connector[3]. Use a one-half inch strap wrench with a "soft" strap[4].

4. Use non-petroleum products such as alcohol, Synasol or Freon TF as cleaning fluids [5]. Do not soak the leads or rubber portions of the receptacle[6].

5. Use thread sealant (NAMCO part number EH459-20000) on union elbow assemblies, receptacle, and conduit threads between male receptacle and solenoid valve, etc. R1

6. Follow the manufacturers instructions on assembly torque values[8, 10].

INFORMATION ONLY

REFERENCES AND SOURCES OF INFORMATION

1. QTR-145, pg. 4-5 (TAB D.2).
2. QTR-142, Section 4.9, pages 4-5.
3. Installation Instructions EC219-90002, Section 9.1 (TAB H, page H-8)
4. Installation Instructions EC219-90002, Section 9.2 (TAB H, page H-8)
5. Installation Instructions EC219-90002, Section 9.3 (TAB H, page H-8)
6. Installation Instructions EC219-90002, Section 2.4 (TAB H, page H-8)
7. Installation Instructions EC219-90002, Section 3.3, 3.6 and 3.7 (TAB H, page H-8)
8. Installation Instructions EC219-90002, Section 3.5 (TAB H, page H-8)
9. WAC-299 Material Aging Calculation Report (TAB C, page C-4)
10. Installation Instructions EH709-40000 and EH709-40001 (TAB H, pages H-21, H-22, and H-23).

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 3 OF 5
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED [signature]	DATE 4/27/90	R ___ R ___
	CHECKED [signature]	DATE 4-30-90	

QUALIFICATION MAINTENANCE DATA SHEET (QMDS)

TAB G

B. EQUIPMENT STORAGE REQUIREMENTS

1. Leave the connector protective cap in place until ready for assembly to mating receptacle.

INFORMATION ONLY

REFERENCES AND SOURCES OF INFORMATION

1. Instruction Manual EC219-90002, Section 6.1 (TAB H.5)

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 4 OF 5
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED AFL	DATE 4/27/90	R R
	CHECKED HDR	DATE 4-30-90	

QUALIFICATION MAINTENANCE DATA SHEET (QMDS)

TAB G

2. RECOMMENDED SURVEILLANCE PARAMETERS AND PREVENTATIVE MAINTENANCE

C. RECOMMENDED SURVEILLANCE

1. The receptacle threads, pins, molded insert, lead wire insulation and general condition should be checked anytime the connector/cable assembly is moved.

INFORMATION ONLY

REFERENCES AND SOURCES OF INFORMATION

1. Instruction Manual EC219-90201, Section 2.2 (TAB H.6)

BINDER NO. WBNEQ-CSC-002	PLANT WBN	UNIT(S) 1	SHEET 5 OF 5		
				R	R
BINDER TITLE CONDUIT SEAL ASSEMBLIES	COMPUTED HFL	DATE 4/27/90			
	CHECKED HDR	DATE 4-30-90			

QUALIFICATION MAINTENANCE DATA SHEETS (QMDS)

TAB G

2. RECOMMENDED SURVEILLANCE PARAMETERS AND PREVENTATIVE MAINTENANCE

D. RECOMMENDED PREVENTATIVE MAINTENANCE

None

INFORMATION ONLY

0375Q

ABL - 051

802 901218 008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

BFN/PPC/ ... xc: rhs two tjm lbd teb lem

DEC 14 1990

Docket Nos. 50-259,260, and 296

RECEIVED
DEC 19 1990
NUCLEAR LICENSING AND REGULATORY AFFAIRS

9101020465 (27)

Mr. Oliver D. Kingsley, Jr.
Senior Vice President, Nuclear Power
Tennessee Valley Authority
6N 38A Lookout Place
Chattanooga, Tennessee 37402-2801

Dear Mr. Kingsley:

SUBJECT: ENVIRONMENTAL QUALIFICATION (10 CFR 50.49) INSPECTION (50-259,260,296/90-22)

Enclosed is the report of the team inspection conducted by Mr. G. T. Hubbard and other NRC representatives on June 25-29, 1990, at the Browns Ferry Nuclear Plant (BFN) of activities authorized by NRC License Nos. DPR-33, DPR-52, and DPR-68. The inspection findings were discussed with Mr. N. C. Kazanas and other members of your staff on June 29, 1990.

The inspection was a continuation of the NRC's evaluation of BFN's implementation of an environmental qualification (EQ) program to comply with the requirements of 10 CFR 50.49. The inspection included the review of inspection findings from the NRC EQ Inspection (Inspection Report 50-259,260, 296/88-11 dated September 1, 1988), conducted May 9-13, 1988. Additionally, the inspection included a review and evaluation of EQ program activities completed since that inspection. Within these areas, the inspection consisted of examinations of selected procedures and records, interviews with personnel, and observations by the inspectors.

The inspection identified no deficiencies in BFN's implementation of a program to meet the requirements of 10 CFR 50.49. Inspection Follow-up Items 50-259,260,296/88-11-01 through 04 and Unresolved Items 50-259,260,296/88-11-05 and -06 from the May 1988 EQ Inspection were closed during the inspection. In addition, the inspection closed Violation "C" (50-260/89-16-03) and Inspection Follow-up Item (50-260/89-16-11) of NRC Inspection Report 50-259,260,296/89-16 dated March 9, 1990.

INFORMATION ONLY

The inspection determined that BFN has implemented a program to establish and maintain the qualification of equipment within the scope of 10 CFR 50.49; however, the program was not fully implemented at the time of the inspection. Browns Ferry is required to complete the implementation of the program prior to restart of the plant. In accordance with the confirmatory item of Section 3.2 Environmental Qualification of Electrical Equipment, NUREG-1232, Volume 3, Supplement 1, "Safety Evaluation Report on Tennessee Valley Authority: Browns Ferry Nuclear Performance Plan," dated October 1989, BFN is required to certify to the NRC, prior to restart, that the BFN 10 CFR 50.49 List is complete and all electrical equipment within the scope of 10 CFR 50.49 is qualified to the requirements of 10 CFR 50.49.

RECEIVED
CHATTANOOGA, TENN.
DEC 18 1990
OFFICE OF
SENIOR VICE PRESIDENT
NUCLEAR POWER

CABL - 051

UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
DIVISION OF SYSTEMS TECHNOLOGY

Report Nos.: 50-259, 260, and 296/90-22

Docket Nos.: DPR-33, DPR-52, and DPR-68

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

Inspection Conducted: June 25-29, 1990

Inspectors George T. Hubbard 12/10/90
G. T. Hubbard, Inspection Team Leader Date

R. C. Wilson, Senior Reactor Engineer

N. Merriweather, Reactor Inspector

Consultants: S. Carfagno, K. Iepson, M. Jacobus, and W. Carpenter

Approved by: C. McCracken 12/10/90
C. E. McCracken, Chief Date
Plant System Branch

INFORMATION ONLY

The NRC inspectors conclude that the licensee's treatment of "Essentially Mild" environments is satisfactory. Although one calculation lacked hardware-specific detail, it is being revised and the licensee's internal audit process is addressing the concern. The other two calculations were considered acceptable.

6.1.2 EQDP-CABL-020 and -037

The inspectors review of EQDP-CABL-020, Okonite power and control cable with ethylene propylene rubber insulation and a Hypalon jacket and EQDP-CABL-037, Okonite power and control cable with "X-Olene-FMR" (cross-linked polyethylene (XLPE)) insulation with a Hypalon jacket, identified that the established qualified life of 40 years at 90°C for these cables was not based solely on Arrhenius aging methodology. Based on the Arrhenius technique for thermal aging, the cables are considered to have a qualified life of 7.4 years at 90°C or 40 years at 72°C.

The qualified life of 40 years at 90°C, was based on information from the cable vendor. In the vendor's method for establishing qualified life, an Arrhenius aging line was established for the cable materials and an adjustment factor was applied based on data of naturally aged cable materials. From this information the vendor established the thermal aging time equivalent to 40 years of qualified life.

The vendor used the cable material parameter of percent retention of elongation to establish an adjustment factor. This factor is based on samples of cables (polyethylene and rubber), which have been naturally aged to as much as 49 years in some cases. From the sample cables, the vendor demonstrates that the percent retention of elongation of naturally aged cable materials (over a range of temperatures) is greater than the percent retention of elongation which would be predicted by Arrhenius methodology. The vendor concludes that naturally aged cables do not age as much as would be predicted by Arrhenius and the use of an adjustment factor is acceptable since it is more representative of how cables actually aged in installed applications.

Additionally, the vendor makes the case that the cable materials used today are even better than the naturally aged cable materials on which he based his conclusions. Therefore, the new cable materials can be expected to be more resistant to aging (i.e., have a greater percent retention of elongation) than the naturally aged cable materials on which the adjustment factors are based.

The inspectors evaluated the qualification of the above cables and determined that qualification of the subject cables is acceptable for 40 years at 90°C based on the following points.

- The approach used has been previously accepted for demonstration of qualification at some other plants.
- The determination of qualified life is based on actual material aging data from naturally aged cables.
- The materials used in these cables are some of the latest and best compounds available for use in the cable industry today.

- Other cable manufacturers have been able to qualify the materials of the same type (with some variations in ingredients and mixing) for 40 years at 90 degrees using the Arrhenius methodology.

In addition to the above points, the inspectors determined that electrical maintenance instructions at BFN require observation and documentation of electrical wire for wire insulation damage during maintenance activities. Through these requirements, the licensee would be able to identify and correct any age related cable degradation, should it occur, before it became a problem.

6.1.3 EQDP-SOL-009

Because of problems at other operating plants, the NRC has a generic interest in lubricants used for O-rings in control solenoid operated valves (SOVs) for Automatic Valve Corporation main steam isolation valves (MSIVs). Accordingly, this binder was evaluated in more detail than is typical for an EQ binder review. The licensee uses a thin film of Dow Corning 200 lubricant with a viscosity of 100,000 centistokes (cSt). A Wyle Laboratories EQ test report 17514-1 documented failures of SOVs with similar lubricants, because the valve actuating spring could not overcome the resistance of the lubricant gelled by radiation damage. Additional test specimens with thin films of lubricants, or no lubricant at all, passed the tests. Although no successful test specimen had O-rings lubricated with Dow 200, it was used on the plunger of test specimen 9D and Parker Super-O-Lube (an identical material) was used on the static seals of specimen 9D.

The licensee acknowledges that the threshold radiation dose of 1.0E6 rad for gellation of 100,000 cSt Dow 200 is well below the five year normal service dose of 8.3E6 rad. The O-ring lubricant is regarded as an assembly aid only, not as an operating lubricant. The test failures are regarded as caused by the presence of a significant quantity of degraded lubricant, and the test successes are attributed to the presence of little or no degraded lubricant. This analysis is carried through the maintenance section of EQ binder BFN2EQ-SOL-005 to the plant maintenance procedure MCI-0-001-PNL001, "Main Steam Isolation Valve Cylinder and Air Control Panel Disassembly, Inspection, Rework, and Reassembly," Revision 5, which specifies cleaning the SOV and that the lubricant "must be applied as a light film." Since the valves must only be operable for one hour after an accident and the accident radiation dose of 3.6E6 rad is relatively small compared to the normal operation dose, periodic surveillance can confirm the operability of the valve. The licensee noted that increased radiation resistance can be obtained by selecting a lower viscosity lubricant; Dow Corning 200 is available in 23 different viscosities. The highest viscosity was selected primarily because of its flash point of 620°F (the flash point of 20 cSt is only 474°F).

The licensee stated that some evidence of lubricant degradation was observed in 1984. None had been noted since, and all of the valves have been refurbished in 1990, so that dissembly and inspection at this time would not likely produce any beneficial results.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 2

The NRC reviewer questioned whether insulation resistance measurements were taken during the LOCA test and if the leakage current values were identified (EQ binders as denoted in RAI Enclosure 3).

Insulation resistance (IR) measurements are typically taken during the LOCA test and documented in the test report contained in Tab D, titled "Miscellaneous Documents And Correspondence," of the cable EQ binders. There were two cases where IR measurements were not taken during the LOCA test. In one case (EQ Binder CABL-010 for Belden signal cable), the applied voltage and current was monitored on the data recorder throughout the LOCA test and leakage currents were monitored periodically. In the other case (EQ Binder CABL-036 for Rockbestos low voltage silicone rubber cable), the test specimen was energized during the LOCA test but no leakage currents were taken. The test was performed to IEEE-383-1974 standards.

Leakage current values are not typically identified for cables in the qualification test report.

Attached is an example of insulation resistance data for EQ Binder CABL-051 for Okonite low voltage power and control cable.

INFORMATION ONLY

1.4.1.5 Test Program (Test Sequence)

(a) Sample Selection.

*(b) Pre-test electrical and physical (mechanical) characteristics -- to determine if samples are representative samples; capacitance, % PF and IR.

(c) Thermal aging of two samples: 3 weeks at 150°C followed by electricals.

(d) Irradiation of samples: 200M rads.

*(e) Pre-LOCA electrical characteristics -- to determine condition of samples prior to LOCA.

(f) Installation of samples into LOCA vessel.

*(g) Pre-LOCA insulation resistance measurements and 5 min. 80 V/mil ac withstand test, to determine if samples were damaged during installation.

(h) Chemical solution sprayed into vessel.

(i) Initiation of LOCA simulation (see Profile - Appendix 1).

(j) Maintenance of LOCA profile thru 30 days.

*(k) IR measurements taken periodically during 30 day period.

*(l) 30 day Post-LOCA simulation test (para. 2.4.4 of 383 - 40 x OD bend, 80 V/mil ac, 5 minutes).

(m) Reinstallation of sample into vessel for additional 100 days at 212°F.

*(n) IR measurements taken once every two weeks.

(o) 130 day Post-LOCA simulation test (para. 2.4.4 of 383 - 40 x OD bend, 80 V/mil ac, 5 minutes).

*(p) Electrical and physical (mechanical) characteristics after LOCA.

*(q) Dielectric strength.

*Electrical or physical tests performed are not requirements of IEEE 323 or 383.

NOTE: Procedure and test results of the Vertical Tray Flame Tests are contained in Appendix 7.

1.4.1.6 Test Results

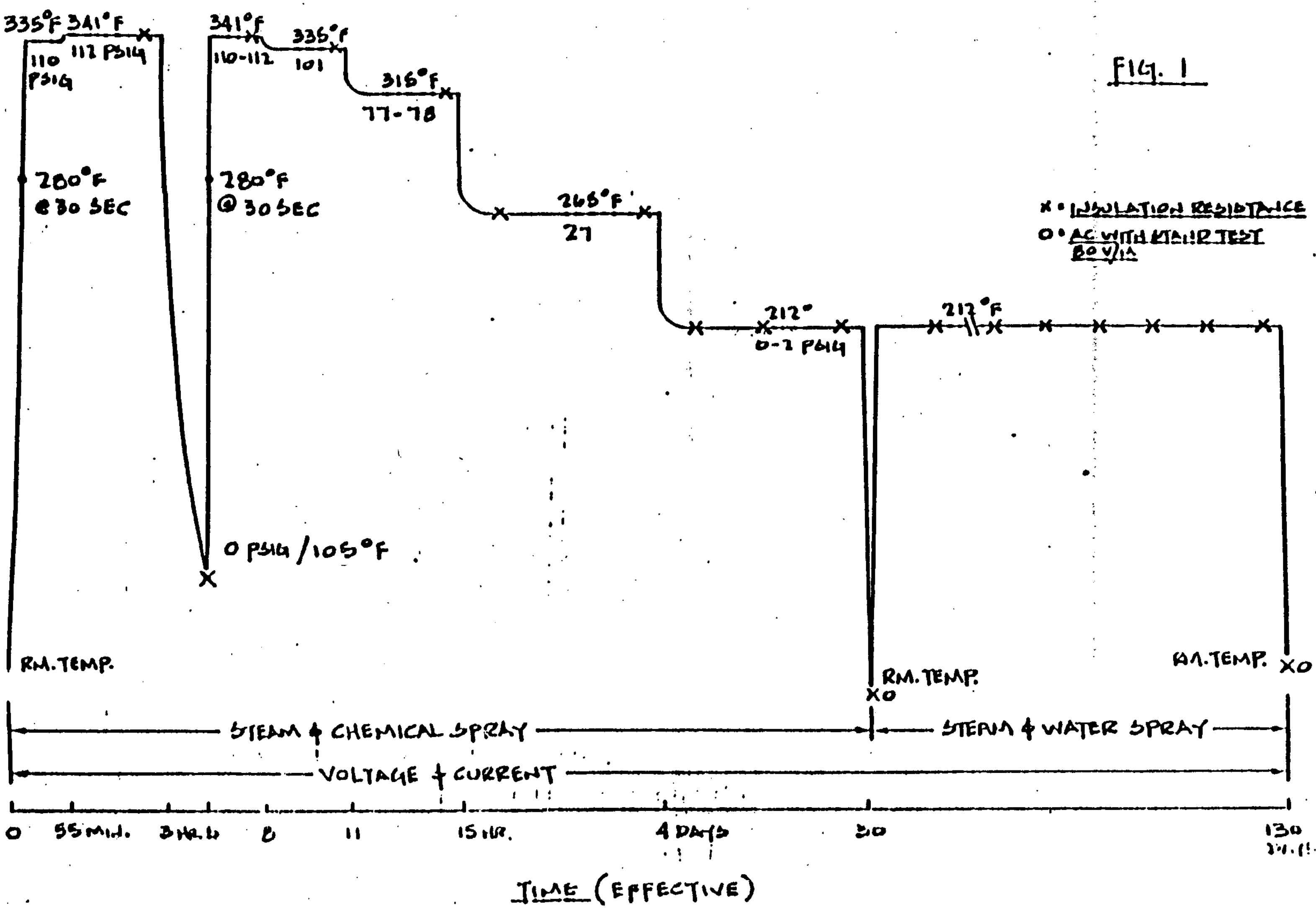
(a) The aged specimen maintained the electrical load as given in paragraph 1.4.2.4 throughout the entire profile. The electrical load on the unaged specimen was interrupted from the first day at 265°F through the 30th day due to a termination failure. (See Appendix 10, item 3.) R3

(b) All samples passed the 30 and 130 day Post-LOCA simulation tests (40 x OD, 80 V/mil ac for 5 minutes immersion in water).

(c) A margin of assurance was demonstrated by:

CABLE QUALIFICATION TEST PROFILE FOR SEQUENTIAL LOCA 1078-10

FIG. 1



E3-19

PAGE D-8

CABL-051

APPENDIX 1

INFORMATION ONLY

THE OKONITE COMPANY
Ramsey, New Jersey 07446

APPENDIX 9

INSULATION RESISTANCE
MΩ - 1000 ft.

CABL-051

X-Olene-FR

Time & Temperature	Unaged Sample 1	Unaged Sample 2	Aged Sample 1	Aged Sample 2
Pre LOCA @ 64°F	2.5 E3	2.5 E3	2.3 E3	[illegible] E3
First Peak @ 341°F	<2.5 E-3 @ 50V	1.4 E1	6.3 E0	[illegible] E-2
Between Peaks @ 107°F	"	2.6 E3	2.5 E3	[illegible] E3
2nd Peak @ 341°F	"	2.4 E1	8.3 E0	6.3 E0
Plateau @ 335°F	"	3.1 E1	2.6 E0	3.4 E0
Plateau @ 315°F	"	7.5 E1	8.5 E0	8.[illegible] E0
After 1 day, 265°F	"	2.5 E-3 @ 50V	1.1 E2	9.[illegible] E2
After 4 days, 265°F	"	"	6.3 E1	6.[illegible] E1
After 7 days, 212°F	"	"	8.5 E2	3.[illegible] E3
After 15 days, 214°F	"	"	1.1 E3	1.1 E3
After 21 days, 212°F	"	"	1.1 E3	1.1 E3
After [illegible] days, 213°F	"	"	1.2 E3	1.3 E3
After 30 days, 84°F	"	"	7.0 E3	7.0 E3
After 34 days, 212°F	8.8 E2	1.8 E3	1.1 E3	1.6 E-1 @
After 48 days, 212°F	8.3 E2	1.9 E3	9.4 E2	2.0 E-1 @ 100V
After 64 days, 212°F	1.5 E3	2.0 E3	1.2 E3	1.8 E-1
After 85 days, 213°F	1.9 E3	2.2 E3	1.1 E3	2.3 E-1
After 100 days, 212°F	4.8 E2	7.2 E2	6.3 E2	<2.3 E-1 @ 100V
After 116 days, 212°F	2.4 E2	3.3 E2	2.5 E2	"
After 129 days, 213°F	4.0 E2	6.2 E2	3.7 E2	5.[illegible] E-1
After 130 days, 70°F	1.5 E3	2.1 E3	2.4 E3	3.5 E-1

Tests performed at 500 volts dc unless otherwise indicated.

Prepared by: J R Cancelosi 3/30/87
J. R. Cancelosi

Approved by: J S Lasky 3/30/87
J. S. Lasky

PAGE D-32

E3-20

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 3

The NRC reviewer asked what is meant by the term "fail safe circuit" with regard to submergence.

A "fail safe circuit" is a circuit that is designed to perform its safety function on loss of power, (i.e., go to its safe-shutdown or safe required position). If a cable supplying a fail-safe device were to be submerged, it could possibly short, causing its protective device to open. This action would de-energize the cable, but there would be no compromise to plant safety because the end device was designed to fail in its safe position. Instrumentation circuits which are subject to submergence, are analyzed to ensure that loss of circuit function will not mislead the operator.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Questions 4 and 6

The NRC reviewer questioned why the mechanical, electrical, and process stresses were not considered in the cable qualification test and asked if IEEE 383-1974, Paragraphs 1.3.4.1 and 2.3.1 justify equipment as being satisfactory for vibrational characteristics.

The mechanical, electrical, and process stresses are not considered in the cable qualification test because IEEE 383-1974, Paragraph 1.3.4.1, which is referenced in all the cable EQ binders, allows evidence of service condition suitability to be based on compliance with appropriate published industry standards. All of TVA's cables are purchased to an Insulated Cable Engineers Association (ICEA) or Insulated Power Cable Engineers Association (IPCEA) standard, except for cables in EQ binders CABL-013, CABL-047, and CABL-061. Cables in Binder CABL-061 (Rockbestos coaxial cables) were manufactured under an approved quality control program and tested to IEEE Standards 323 and 383. See Rockbestos letter to TVA dated September 1, 1989 (copy attached).

EQ binders CABL-013 and CABL-047 are for signal cables which are NUREG-0588, Category II and qualified to IEEE 323-1971. These cables were manufactured to Military Specifications, since no ICEA or IPCEA standard exists for this type cable.

Paragraphs 1.3.4.1 and 2.3.1 of IEEE 383-1974 do not justify equipment as being satisfactory for vibrational characteristics; however, IEEE 383-1974 does allow the use of published industry standards to show that service conditions are met.

(Copy of IEEE-383-1974, Paragraphs 1.3.4.1 and 2.3.1, attached.)

THE ROCKBESTOS COMPANY
285 NICOLL STREET, P.O. DRAWER 1102, NEW HAVEN, CT 06504 (203) 772-2250

CABL-061

Don Arp

INFORMATION ONLY

September 1, 1989

Mr. Don Arp
Tennessee Valley Authority
Browns Ferry Nuclear Plant   Trailer 16
PO Box 2000
Decatur Alabama 35602

SUBJ: Rockbestos Coaxial Cable RSS-6-105/LE
Industry Standards/Specification

Dear Mr. Arp,

Rockbestos Coaxial Cables, RSS-6-100 series in general and RSS-6-105/LE in particular, are engineered products designed to meet the unique requirements of the nuclear power generating industry.

Since they are specially designed cables, their properties and characteristics do not fit existing industry standards such as ICEA S-66-524 (For "Crosslinked Thermosetting Polyethylene Insulated Wire and Cables for the Transmission and Distribution of Electric Energy") or MIL-C-17/F (Cables, Radio Frequency, Flexible and Semirigid, General Specification For). They are, however, manufactured to Rockbestos' specification under an approved quality control plan and they have been tested and qualified to IEEE standards 323 and 383.

RIMS, ETSLE28P-K

PAGE E-14

Because of their acceptance and use by a majority of the nuclear utilities and their recommendation by various radiation monitoring instrumention suppliers, they have achieved the status of a de facto standard unto themselves.

Very truly yours,

THE ROCKBESTOS COMPANY

R.J. Gehm

R.J. Gehm
Manager, Electrical & Product Engineering

cc G.S. Klein
G.G. Littlehales
E.J. D'Aquanno

INFORMATION ONLY

rjg.159

then, with engineering knowledge and experience in insulating materials and systems form a basis for designing type tests to demonstrate the capabilities. Qualification of one cable may permit extrapolation of results to qualify other cables of the same type, with consideration being given to cable dimensions and probable modes of failure.

A sample field splice or connection or both must be type tested with the cable to demonstrate its electrical, mechanical, and chemical compatibility in the environments.

1.3.1 *Cable Description.* This description or specification should include as a minimum:

1.3.1.1 Conductor — material identification, size, stranding, coating.

1.3.1.2 Insulation — material identification, thickness, method of application.

1.3.1.3 Assembly (multiconductor cables only) — number and arrangement of conductors, fillers, binders.

1.3.1.4 Shielding — tapes, extrusions, braids, or others.

1.3.1.5 Covering — jacket or metallic armor or both, material identification, thickness, method of application.

1.3.1.6 Characteristics — voltage and temperature rating (normal and emergency). For instrumentation cables — capacitance, attenuation, characteristic impedance, microphonics, insulation resistance, as applicable.

1.3.1.7 Identification — manufacturer's trade name, catalog number.

1.3.2 *Field Splice or Connection Description or Both.* This description or specification should include as a minimum:

1.3.2.1 Whether factory or field assembled to cable.

1.3.2.2 Conductor connection — type, material identification, and method of assembly.

1.3.2.3 Items from Sections 1.3.1.2 through 1.3.1.7.

1.3.3 *Description of Significant Environmental Conditions.* Both normal operating and design basis event conditions, as well as their sequence and duration, are relevant for type testing. Separate requirements for post design basis event conditions may be required in recognition of momentary or accumulative changes in material properties due to aging, radiation, heat, and steam exposure. Environmental factors, the limits of which may be significant to the cable's operation are as follows:

1.3.3.1 *Atmosphere.* Maximum and average ambient or normal operation condition and design basis event condition or profile for the following:

(1) Gas composition and velocity
(2) Moisture content
(3) Temperature
(4) Pressure

1.3.3.2 *Radiation.*

(1) Normal dose rate and type
(2) Total normal installed life dosage
(3) Design basis event dose rate. Maximum dose rate and approximate profile
(4) Total design basis event dosage
(5) Total for the installed life plus design basis event

1.3.3.3 *Chemicals*

(1) Type of chemicals and concentration
(2) Spray or immersion rate and time
(3) Temperature of exposure

1.3.3.4 *Mechanical.* Normal operating condition and design basis event condition for the following:

(1) Bending or flexing
(2) Vibration
(3) Tension
(4) Sidewall pressure

1.3.3.5 *Fire*

1.3.4 *Operating Requirements*

1.3.4.1 *Meeting Service Conditions.* The cable, as installed, should be suitable for operation at maximum ambient temperature, radiation, and atmospheric conditions and normal electrical and physical stresses for its installed life, as specified. Evidence of this suitability may be based on compliance with appropriate published industry standards, past documented operating experience, component tests, or a combination of these.

The total station may be subdivided into zones with substantially different ambient conditions, and if segregation of cables to certain areas is assured, a cable need only be suitable for meeting service conditions in those zones in which it is located.

1.3.4.2 *Design Basis Event Conditions for Qualifying Cables*

1.3.4.2.1 *Design Basis Event — Loss-of-Coolant Accident (LOCA) (for cables in containment only).* The cable, field splices, and connections should throughout their normal lives be capable of operating through postulated environmental conditions re-

1.4.3 *Test Results*. Test results should demonstrate that:

1.4.3.1 The intended environmental sequences were achieved.

1.4.3.2 The cable or field splice (or connection) or both was capable of performing its intended function.

1.4.4 *Test Evaluation*. An evaluation of data should be made to demonstrate the adequacy of cable performance as outlined in Section 1.4.1.4.

1.5 Modifications. When modification in the materials or design of cables or in the conditions of installation or in the postulated environments are made, prior type tests shall be reviewed to determine the effect on the cable qualification. This evaluation shall indicate whether or not new type tests are required. The analysis of data and evaluation that demonstrates the effect of the modification on the equipment performance shall be added to the qualification documentation.

2. Examples of Type Tests

2.1 Introduction. Type tests described in this document are examples of methods which may be used to qualify electrical cables, field splices and connections for use in nuclear power generating stations. Tests of the cable or connection assembly, as applicable, should then supplement the cable tests in order to qualify the connections and other aspects unique to planned usage.

The values of pressure, temperature, radiation, chemical concentrations, humidity, and time used do not represent acceptable limits for all nuclear power generating stations. The user of this guide should assure that the values used in the required type tests represent acceptable limits for the service conditions in which the cable or connections, or both will be installed.

Results of prior tests that are being used as the bases for the present tests should be referenced in the documentation.

2.2 Type Test Samples. The samples tested should contain the conductor, insulation, fillers, jacket, binder tape, overall jacket, shielding, and field splices which are representative of the cable category being qualified. Table 1 lists sizes which have been considered representative of these categories. The sample lengths should be sufficient to permit reliable test readings and evaluation consistent with good testing practice.

2.3 Testing to Qualify for Normal Operation

2.3.1 *Temperature and Moisture Resistance*. Evidence of qualification for normal operation may be demonstrated by providing certified evidence that the cable has been manufactured and tested and passed in accordance with the provisions of one or more of the following industry standards or criteria.

ANSI C83.21-1972 Requirements for Solid Dielectric Transmission Lines

ANSI C96.1-1964 (R1969) Temperature Measurement Thermocouples

ANSI C1-1971 National Electrical Code, NFPA 70-1971, Sections on Types RHH, RHW, and XHHW[2]

IPCEA S-19-81 Rubber-Insulated Cable

IPCEA S-66-524 Cross-Linked-Polyethylene-Insulated Cable

IPCEA S-68-516 Interim Standards for Ethylene-Propylene-Rubber-Insulated Wire and Cable. Number 1, Cables Rated 0-35 000 V. Number 2, Cables Rated 2000 V, Integral Insulation and Jacket.

AEIC 5-71 Specifications for Polyethylene and Cross-Linked-Polyethylene-Insulated, Shielded Power Cables rated 5000–35 000 V

AEIC 6-73 Specifications for Ethylene-Propylene-Rubber-Insulated Shielded Power Cables Rated 5–46 kV

2.3.2 *Long-Term Physical Aging Properties*. Aging data should be submitted to establish long-term performance of the insulation. Data may be evaluated using the Arrhenius technique. A minimum of 3 data points, including 136 °C and two or more others at least 10 °C apart in temperature, should be used.

2.3.3 *Thermal and Radiation Exposure*. The following test sequence may be used to demonstrate that the cable will be operational after exposure to simulated thermal and radiation aging.

[2] Cable types RHH, RHW, and XHHW, as specified in the National Electrical Code should meet the requirements established by the applicable standards of Underwriters' Laboratories, Inc or other recognized agencies.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 5

The NRC Reviewer questioned the need to list activation energies when employing the Arrhenius method.

For response refer to response to Question 3 in Enclosure 1.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 7

The NRC reviewer questioned whether the word "normal" in EQ Binder CABL-010 for Belden signal cable was meant to be "normal" or "nominal."

The word was meant to be "nominal."

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 8

The NRC reviewer stated that anomalies considered to have no significant impact must be listed and that some anomalies seemed subject to scrutiny.

Tab B, Section M (Operability Test Results), Question 5 of the EQ binder addresses test anomalies and their resolution. Each anomaly noted in the Qualification Test report was reviewed and dispositioned by the report, concurred with by the binder preparer and subsequent reviewers. Some anomalies were noted as insignificant because they did not apply to the specific model being qualified by the binder. Other examples of insignificant anomalies were those concerning failures of the test equipment if appropriate measures were taken to negate the effects of those failures (example, aging times extended to make up for shutdown of test for repairs or replacement of malfunctioning test equipment).

Attached are two examples EQ binders CABL-049 and HS-002 of Tab B, Section M which show typically how this question is addressed. References to pertinent sections of the binder are made as appropriate.

M. OPERABILITY TEST RESULTS

(1) Identify the safety function(s) of this equipment: (Reference See Comments).

JUSTIFICATION/COMMENTS To maintain continuity and integrity for use in control and instrumentation circuits during and following a DBE. (See also TAB A and TAB C, Section A.6.) R1

(2) Did the equipment perform its intended function during the simulated design basis accident exposure (yes/no/NA)? Yes (Reference Report 1, App. E, Sect. 4.3, p. 5, and Data sheets on pp. 16-26). R1

JUSTIFICATION/COMMENTS See also TAB C, Section A.6.

(3) Did the equipment perform its intended function during the simulated post-design basis accident exposure (yes/no/NA)? Yes
(Reference See TAB B, Section M[2]).

JUSTIFICATION/COMMENTS

(4) Did the test demonstrate the operability requirements for the required time interval for which the equipment is required to operate (yes/no/NA)? Yes* (Reference **). R1

JUSTIFICATION/COMMENT *Equivalent time **See TAB C Section A.4 and Section A.6.

(5) Abnormal Conditions: Were abnormal conditions or anomalies properly addressed and resolved (yes/no/NA)? Yes
(Reference Report 1, App. G).

JUSTIFICATION/COMMENTS Anomalies were reviewed and the dispositions did not significantly impact the qualification program. Completion of test is valid and the results acceptable.

INFORMATION ONLY

M. OPERABILITY TEST RESULTS

(1) Identify the safety function(s) of this equipment:
(Reference: Sec. XII, Par. 2.2.2.3).

JUSTIFICATION/COMMENTS No change of state of all contacts during DBA.

(2) Did the equipment perform its intended function during the simulated design basis accident exposure (Yes/No/NA)? Yes
(Reference: Sec. X, Par. 3.0).

JUSTIFICATION/COMMENTS See discussion in TAB B, Section P.

(3) Did the equipment perform its intended function during the simulated post-design basis accident exposure (Yes/No/NA)? Yes
(Reference: Sec. X, Par. 3.0).

JUSTIFICATION/COMMENTS

(4) Did the test demonstrate the operability requirements for the required time interval for which the equipment is required to operate (Yes/No/NA)? No (Reference: NA).

JUSTIFICATION/COMMENTS See TAB B, Section K(8).

(5) Abnormal Conditions: Were abnormal conditions or anomalies properly addressed and resolved (Yes/No/NA)? Yes
(Reference: Summary).

JUSTIFICATION/COMMENTS Appropriate test report sections and TAB B, Section P.

INFORMATION ONLY

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 9

The NRC reviewer questioned whether jacketed (sacrificial) material should be listed as a material susceptible to significant thermal/radiation degradation.

Even though cable jacket material may be discussed in some binders, TVA does not take credit for the jacket material in the qualification of the cable. There is one exception to this statement in that TVA uses double jacketed coaxial cable that is addressed in EQ Binder CABL-061. Thermal/radiation degradation for the cable inner jacket material is addressed in that binder.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 10

The NRC reviewer questioned improperly referenced or missing footnotes.

Regarding the specific components addressed by this question, the EQ Binder CABL-053 for Rockbestos power and control cable has the footnote correctly listed on the next page. The missing footnote in EQ Binder ILT-001 for Foxboro model E13DM pressure transmitters was identified and corrected by Revision 2 dated February 15, 1991.

Attached is an example of the footnotes in EQ Binder CABL-053 for Rockbestos (type XLPE) power and control cables. EQ Binder ILT-001 has a similar footnote arrangement.

K. REQUIRED OPERATING ENVIRONMENT

Reference Environmental Drawing No. See comment * under K.(5) comments on Page B-19

(1) Normal Max

(a) Temperature (°F) 130

(b) Pressure (psia) 14.7

(c) Humidity (%) 80

(d) Radiation (rd) 5.8E+07

(2) Abnormal Max

(a) Temperature (°F) 140

(b) Pressure (psia) 14.7

(c) Humidity (%) 100

(d) Radiation (rd) NA

(3) Process Interfaces:

Not applicable for cable qualification

(4) State anticipated occurrence frequency and duration of abnormal conditions:

Up to eight hours per excursion and will occur less than one percent of the life of the plant.

(5) Accident (worst case for any combination of specified accident parameter including peak, duration, and profile):

(a)	Temperature (°F)	325 (IC) 535 (MSVV)	Accident type LOCA/HELB
(b)	Pressure (psia)	25.6	Accident type LOCA
(c)	Humidity (%)	100	Accident type LOCA
(d)	Radiation (rd)	1.2E+08 (AGBTS) 1.21E+08 (EGTS) 9.33E+07 (IC)	Accident type LOCA |R1
(e)	Spray Type	Chemical**	Accident type LOCA/HELB

(SEE FOOTNOTES ON NEXT PAGE)

K. REQUIRED OPERATING ENVIRONMENT (Continued)

Comments (duration/peak/profile/spray composition and pH, margin, etc.):

* The values shown do not necessarily reflect the installed environment; however, the values are representative of the worst case environment permitted and were derived from the following sources after a review of all environmental drawings and pertinent calculations was performed. For future installations see Tab B, Section B.

Section(s)	Reference/Source	
1a, 2a	(3) 47E235-76 MSVV	
1b, 2b, 1c, 2c, 1d, 2d	(3) 47E235-42 IC	R1
5a (535°F)	(3) 47E235-76 MSVV and Tab C, Section B (2.0)	
5a (325°F)	(-) WAC-365 located in Tab C, Section A. (Value rounded up from 324.8°F)	
5b, 5c	(3) 47E235-42 IC	
5d (1.2E+08)	(3) 47E235-48 ABGTS	R1
5d (1.21E+08)	(-) Tab C, Section B (5.0)	
5d (9.33E+07)	(-) Tab C, Section B (6.0)	R1

** See Note 22 on 47E235-42 for chemical spray content.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 11

The NRC reviewer had several questions regarding various aspects of submergence.

Submergence is addressed in Enclosure 1.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 12

The NRC reviewer questioned how the demonstrated operating time was determined to establish equivalency to the specified operating time.

As discussed below, the EQ Program addresses such concerns and, in fact, the relevant information is included in the EQ binders.

The EQ Program provides for the review of accident degradation equivalency through the process which is documented in the generic EQ Binder GEN-001.

Regarding the specific components addressed by this question, the demonstrated operating time was determined from the actual duration of the design base event (DBE) test performed on the components qualified by the subject EQ binders.

Attached is an example of the EQ binder Tab B and Tab C discussion of accident degradation equivalency with respect to Cutler-Hammer handswitches (EQ Binder HS-002).

Tab B

L. SUMMARY COMPARISON OF TEST CONDITIONS TO SPECIFIED CONDITIONS

(1) Comparison of worst-case maximum parameters:

Parameter	Specified	Demonstrated	Reference
Operating Time	100 days	26.5 Hrs (Note 2)	Sec. X, Fig. X-9
Temperature (°F)	205	330°F	Sec. X, Fig. X-9
Pressure (psig)	ATM (+)	12	Sec. X, Fig. X-9
Relative Humidity (%)	100%	100 (Steam)	Sec. X, Par. 1.1.4
Chemical Spray*	NA	NA	NA
Radiation (rd)**	Gamma 1.8×10^7	1.1×10^6 Gamma (Note 1)	Sec. II, Par. 1.0 & 3.0
Submergence	NA	NA	NA

*Includes spray concentration, flowrate, density, duration, and pH.
**Enter 40-year integrated normal dose plus integrated accident dose and specify type.

(2) Comparison of worst-case profiles and margin assessment:

Parameter	Test Profile Envelopes Specified (Yes/No/NA)	Reference
Temperature	Yes	Sec. X, Fig. X-9
Pressure	Yes	Sec. X, Fig. X-9
Relative Humidity	Yes	Sec. X, Par. 1.1.4
Chemical Spray	NA	NA
Submergence	NA	NA

JUSTIFICATION/COMMENTS

Note 1: See Section P, TAB B, for analysis to support qualification to 1.8×10^7 rads. Note 2: See TAB C, for calculation to justify post-accident profile. For discussion of elevated post-accident temperatures in the auxiliary building due to an inside containment LOCA/HELB, see TAB C.

INFORMATION ONLY

MATERIAL AGING CALCULATION REPORT HS-002

TRANSMITTAL

B44 '900306 875

QA Record

DATE: March 5, 1990

TO: K. F. Liao

FROM: Thomas R. Witmer

BINDER NUMBER: WBNEQ-HS-002

CALCULATION NO.: WAC-292

The attached Material Aging Calculation Report was performed using the System 1000. The System 1000 material aging data base and computer software programs were compiled, written and verified in accordance with Digital Engineering Quality Assurance Program and Operating Procedures and were verified and determined to be acceptable for TVA use by Thomas R. Witmer's memorandum to the Environmental Qualification Project files dated September 25, 1985 (B70850925013).

This calculation includes two sheets labeled "ENVIRONMENTAL QUALIFICATION PROJECT CALCULATIONS PERFORMED BY THE SYSTEM 1000" plus the following calculation sheets:

WAC-292 PLOT 1

Performed By: [signature] Date: 3/5/90

Verified By: Thomas R. Witmer Date: 3/5/90

INFORMATION ONLY

FORM NUMBER: EQTF-005-85
(3-86)

ENVIRONMENTAL QUALIFICATION PROJECT CALCULATIONS

PERFORMED BY THE SYSTEM 1000 HS-002

All material aging calculations performed using the System 1000 are based on the Arrhenius Model. Derivations of the Arrhenius Equations, along with definitions of the various parameters are:

Expected Life

$$\ln(\text{life}) = (Ea/k_B)(1/T) + \text{Constant} \qquad (1)$$

Qualified Life (Single Service Temperature)

$$t_2 = t_1/\exp((Ea/k_B)(1/T_1 - 1/T_2)) \qquad (2)$$

Qualified Life (Multiple Service Temperatures)

$$t_2 = t_1 / \sum_{x=2}^{n+1} P_x \exp((Ea/k_B)(1/T_1 - 1/T_x)) \qquad (3)$$

Degradation Equivalency Analysis

$$t_A = \sum_{y=1}^{n} t_y/\exp((Ea/k_B)(1/T_y - 1/T_A)) \qquad (4)$$

where:

$\ln(\text{life})$ = Expected Life (hours)

Ea/k_B = Slope (Activation energy/Boltzmans' Constant)

T = Temperature (Degrees Kelvin)

Constant = Intercept

t_2 = Qualified Life (hours)

t_1 = Aging Time (hours)

exp = exponent to base e

T_1 = Aging temperature (K)

T_2 = Service temperature (K)

P_x = Fraction of 40-year life at T_x

T_x = Service Temperatures (K)

t_A = Equivalent Time at T_A (hours)

t_y = Time at Temperature T_y (hours)

T_y = Accident Test Temperature(s) (K)

T_A = Baseline Temperature (K)

Cutler-Hammer Model 10250T Handswitch

CALCULATION SUMMARY

B44 '900306 875

HS-002

ACTIVATION ENERGY (eV): 1.25

PEAK TEMPERATURES: Enveloped with MARGIN
POST-ACCIDENT REQUIREMENT: 100 days
POST-ACCIDENT SIMULATION: 1.10416666667 days
DEGRADATION EQUIVALENCY: 119.393644528 days
CONSERVATISM FACTOR: 19.3936445279 %
ENVIRONMENTAL DWG NO: WBN GEN #1, R0 - HELB & LOCA W/ P-2351-A, W/O P-04174, WAC-313
SIMULATION TEST REPORT NO.: 17503-1, Fig. X-9, Dated 01/06/84

REQ FILE NAME: WBN01000
SIM FILE NAME: J:SIM115A

Requirements Time (seconds)	Temperature (F)	Temperature (C)	Simulation Time (seconds)	Temperature (F)	Temperature (C)
1	104	40	1	104	40
2	182.5	83.6111	5	222	105.5556
4	199.66	93.1444	10	236	113.3333
5.8127	205.5785	96.4325	15	300	148.8889
6	207.5	97.5	20	338	170
7	212.97	100.5389	25	322	161.1111
8	218.65	103.6944	30	312	155.5556
22	218.65	103.6944	35	336	168.8889
24	216.75	102.6389	40	335	168.3333
32	216.75	102.6389	45	328	164.4444
33.2855	215.5352	101.964	50	320	160
36	215.93	102.1833	55	332	166.6667
45.5661	215.9163	102.1757	60	336	168.8889
46	216.04	102.2444	300	311	155
46.3118	215.9153	102.1752	600	323	161.6667
50	215.91	102.1722	900	320	160
59.5023	215.7903	102.1057	1200	309	153.8889
60	215.85	102.1389	1500	300	148.8889
60.4193	215.7787	102.0993	1800	287	141.6667
68.6673	215.6748	102.0416	2100	277	136.1111
70	215.92	102.1778	2400	268	131.1111
71.4286	215.64	102.0222	2700	256	124.4444
78.7949	215.5472	101.9707	3000	243	117.2222
80	215.74	102.0778	3300	236	113.3333
85	216.13	102.2944	3600	227	108.3333
90	215.51	101.95	5400	216	102.2222
95	216.12	102.2889	7200	214	101.1111
100	215.28	101.8222	9000	210	98.8889
120	216.18	102.3222	10800	210	98.8889
330	216.18	102.3222	12600	208	97.7778
340	216.13	102.2944	14400	207	97.2222
346.9903	215.9203	102.1779	16200	204	95.5556
359.3448	215.7314	102.073	18000	203	95
363.9847	215.7495	102.0831	19800	197	91.6667
370	215.93	102.1833	21600	200	93.3333
380	216.06	102.2556	23400	193	89.4444
390	216.1	102.2778	25200	197	91.6667
392.4198	215.8604	102.1447	27000	190	87.7778
400	215.89	102.1611	28800	191	88.3333
417.7674	215.8278	102.1266	30600	185	85

INFORMATION ONLY

BINDER NO: WBNEQ-HS-002
LOCA (R3.0)

PAGE C-20 R1

E3-42

WAC-292, PLOT 1

Cutler-Hammer Model 10250T Handswitch

B44 '900306 875

CALCULATION SUMMARY

HS-002

ACTIVATION ENERGY (eV): 1.25

PEAK TEMPERATURES: Enveloped with MARGIN
POST-ACCIDENT REQUIREMENT: 100 days
POST-ACCIDENT SIMULATION: 1.1041666667 days
DEGRADATION EQUIVALENCY: 119.393644528 days
CONSERVATISM FACTOR: 19.3936445279 %
ENVIRONMENTAL DWG NO: WBN GEN #1, R0 - HELB & LOCA W/ P-2351-A, W/O P-04174, WAC-313
SIMULATION TEST REPORT NO.: 17503-1, Fig. X-3, Dated 01/06/84

REQ FILE NAME: WBN01000
SIM FILE NAME: J:SIM115A

Requirements

Time (seconds)	Temperature (F)	Temperature (C)
420	216.06	102.2556
422.6519	215.8107	102.1171
447.2119	215.7248	102.0693
450	216.09	102.2722
460	216.09	102.2722
466.4441	215.7678	102.0932
489.373	215.9948	102.2193
490	216.06	102.2556
500	216.1	102.2778
547.3936	215.807	102.115
550	215.88	102.1556
551.0031	215.7847	102.1026
562.3482	215.7146	102.0637
600	215.82	102.1222
620	216.02	102.2333
639.3701	215.8263	102.1257
743	218	103.3333
745	216	102.2222
745	215.9513	102.1952
765	216	102.2222
768	215	101.6667
772	214	101.1111
773	213	100.5556
775	212	100
777.9925	211.0025	99.4458
840	211.003	99.4461
880	210.981	99.4339
880.9106	210.8989	99.3883
3600	207.5	97.5
7200	203	95
10800	198.5	92.5
14400	194	90
18000	189.5	87.5
21600	185	85
25200	180.5	82.5
28800	176	80
32400	171.5	77.5
36000	167	75
39600	162.5	72.5
43200	158	70

Simulation

Time (seconds)	Temperature (F)	Temperature (C)
32400	186	85.5556
34200	179	81.6667
36000	180	82.2222
37800	176	80
39600	179	81.6667
41400	173	78.3333
43200	173	78.3333
45000	168	75.5556
46800	172	77.7778
48600	163	72.7778
50400	165	73.8889
52200	160	71.1111
54000	156	68.8889
55800	158	70
57600	156	68.8889
59400	150	65.5556
61200	154	67.7778
63000	150	65.5556
64800	147	63.8889
66600	144	62.2222
68400	144	62.2222
70200	139	59.4444
72000	142	61.1111
73800	135	57.2222
75600	139	59.4444
77400	134	56.6667
79200	130	54.4444
81000	131	55
82800	120	48.8889
84600	122	50
86400	116	46.6667
88200	123	50.5556
90000	119	48.3333
91800	115	46.1111
93600	116	46.6667
95400	115	46.1111

INFORMATION ONLY

E3-43

Cutler-Hammer Model 10250T Handswitch

CALCULATION SUMMARY

B44 '900306 875

ACTIVATION ENERGY (eV): 1.25

PEAK TEMPERATURES: Enveloped with MARGIN
POST-ACCIDENT REQUIREMENT: 100 days
POST-ACCIDENT SIMULATION: 1.19416666667 days
DEGRADATION EQUIVALENCY: 119.393644528 days
CONSERVATISM FACTOR: 19.3936445279 %
ENVIRONMENTAL DWG NO: WBN GEN #1, R0 - HELB & LOCA W/ P-2351-A, W/O P-04174, WAC-313
SIMULATION TEST REPORT NO.: 17503-1, Fig. X-9, Dated 01/06/84

REQ FILE NAME: WBN01000
SIM FILE NAME: J:SIM115A

Requirements Time (seconds)	Temperature (F)	(C)	Simulation Time (seconds)	Temperature (F)	(C)
46800	153.5	67.5			
50400	149	65			
54000	144.5	62.5			
57600	140	60			
61200	135.5	57.5			
64800	131	55			
66853.125	128.4336	53.5742			
68400	127.05	52.8056			
72000	123.84	51.0222			
75600	120.63	49.2389			
79200	117.42	47.4556			
82800	114.21	45.6722			
86400	111	43.8889			
8640000	111	43.8889			

INFORMATION ONLY

E3-44

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 13

The NRC reviewer questioned the reason for elevating the test temperature to a value to cause equipment degradation during the thermal aging test and the magnitude of this temperature.

EQ Binder HS-002 for Cutler Hammer handswitches, Section P(2)b contained a discussion of the anomaly that the green lens had deformed during the test. Evaluation of the anomaly concluded the elevated test temperature caused the deformation. The test temperature was elevated to 110°C (230°F) to shorten the accelerated aging time based upon an activation energy of 0.86 eV.

Attached is a copy of Notice of Anomaly Number 5 from Tab D of the subject EQ binder which addresses deformation of the green lens button during the thermal aging test.

#13 Tab D

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: 9/21/83

NOTICE NO: 5 P.O. NUMBER: TV-56071A CONTRACT NO: N/A
CUSTOMER: Tennessee Valley Authority WYLE JOB NO: 17503-06
NOTIFICATION MADE TO: David Dayton NOTIFICATION DATE: 8/23/83
NOTIFICATION MADE BY: F. Sittason/A. Horsman VIA: Telephone

CATEGORY: ☒ SPECIMEN ☐ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 8/23/83
PART NAME: C-H Illuminated Green Pushbutton Operator PART NO. CH10250T411C22
TEST: Post-Thermal Aging Functional Test I.D. NO. 3.12.1 and 4.12.1
SPECIFICATION: WLQP 17460-3, Rev. B PARA. NO. 3.4.2.3 (Ref. 3.2)

REQUIREMENTS:

After contact resistance/operability tests have been performed on the normally closed and normally open contact, the switch shall be actuated so that contact resistance and operability tests can be performed.

DESCRIPTION OF ANOMALY:

1. The green lens button of each specimen was found to be deformed upon examination after thermal aging.
2. Contact resistance measurements on some of the normally open contacts were outside acceptable limits after actuation.

DISPOSITION - COMMENTS - RECOMMENDATIONS:

1. New lens buttons were inserted so that the operators could be held in their actuated positions for contact and insulation resistance measurement and for the remainder of the qualification program. The operators were operable and none of the contacts had changed state.

   It is judged that deformation of the lens buttons occurred at the elevated accelerated aging temperatures, and that they would not deform at the normal ambient service temperature to which they are exposed. Consequently, the safety-related function of the pushbutton operators was not adversely affected.
2. With TVA's concurrence, the normally open contacts were cycled 20 times at 9 amps. Contact resistance measurements were within allowable limits.

INFORMATION ONLY

VERIFICATION:

TEST WITNESS: N/A
REPRESENTING: N/A
QUALITY ASSURANCE: B. N. Hollingsworth 9/28/83

PROJECT ENGINEER: A. Horsman 9/22/83
PROJECT MANAGER: [signature] 9/28/83
INTERDEPARTMENTAL COORDINATION: [signature] 9/29/83

WYLE Form WH 1066, Rev. Jan. 81

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 14

The NRC reviewer questioned missing pages from Tab A, "Identification of Equipment Comprising Equipment Type," and Tab B, "EQ Checksheets for Evaluation of Environmental Qualification Including Summary and Conclusion," of the subject EQ binders which were previously submitted to NRC.

A review of Tab A and Tab B of the subject EQ binders did not reveal any missing pages.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 15

The NRC reviewer asked why there were different radiation doses for hydrogen analyzer sample pumps qualified by EQ Binder ILP-001.

During the initial qualification testing reported by test report No. 1035-1, Revision 1, Addendum 1, the sample pump failed twice. The sample pump was originally exposed to 1 X 10^6 rads.

Additional testing was done on five more sample pumps (see test report No. 1035-8 in Tab D of this binder). One pump was exposed to 1 X 10^6 rads, two pumps were exposed to 5 X 10^6 rads, and two pumps were exposed to 10 X 10^6 rads.

No reason is explicitly stated in the test reports for selecting three radiation values during additional testing of the sample pumps (test report No. 1035-8). It appears the radiation dose was varied to determine if radiation was a significant contributor to causing the original pump failure. All pumps passed the supplemental test including those exposed to 10 X 10^6 rads (test report No. 1035-8).

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 16

The NRC reviewer questioned how the requirement for synergism can be satisfied when all known synergistic effects were not applicable ("NA"). The reviewer also asked what the threshold is in presence of elevated temperature.

As discussed below, the EQ Program addresses such concerns and, in fact, the relevant information is included in the EQ binder.

The WBN EQ Program provides generally for the review and assimilation of synergistic considerations through guidance given in generic EQ Binder GEN-001.

In EQ Binder ILCV-001 for Masoneilan electropneumatic valve positioners, the "NA" on H(3) should be "Yes" because all synergistic effects are addressed on Page B-14 of the binder. The radiation threshold is much greater than the radiation dose which is considered insignificant. EPRI Report NP-2129 indicates that thermal degradation is not accelerated at a 1.8×10^3 rads dose. This is the only known synergistic effect.

Note, as a result of a design change this binder will be voided.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Questions 17 and 18

The NRC reviewer questions why the equipment was not thermally aged and why the equipment was not aged to the end of life.

The EQ Program addresses such concerns as discussed below.

The EQ Program allows for the qualification of electrical equipment to the criteria of NUREG-0588 Category II, which does not require thermal aging as part of the qualification program for this equipment.

Regarding the specific components addressed by this question, the qualification report in EQ Binder ILT-001 for Foxboro model E13DM pressure transmitters does not address thermal aging; however, as explained in Tab C, page C-3, the qualified life is based on aging of the N-E10 transmitters which have the same components and were thermally aged using the Arrhenius methodology. The test report for N-E10 transmitters is in Tab E-3 of EQ Binder ILT-001.

Attached is an excerpt from EQ Binder ILT-001 which provides a discussion of thermal aging for this transmitter.

BINDER NO. WBNEQ-ILT-001 PLANT WBN UNIT(S) 1 SHEET 1 OF 2

BINDER TITLE FOXBORO XMTR COMPUTED JCH DATE 6/5/86 R ___ R ___

E13 SERIES CHECKED RMR DATE 6/6/86

INFORMATION ONLY

(2) Discussion of Materials, Design, and Testing - TAB B, Section I

As detailed in the test reports listed in Part A of Tab B, Foxboro and Westinghouse have subjected various versions of the Foxboro E10 family of transmitters to nuclear application testing. The subject E13 series transmitters are a part of the E10 family of transmitters. These tests have verified the ability of various versions of the E10 family of transmitters to survive certain radiation and accident parameters. The materials of construction of the E10 family of transmitters has been the same throughout the product line with the exception of some of the electronic components. These components (certain diode, resistor, and capacitor types) are in the amplifier assembly within the electronic (upper) housing. The substitutions were made in the development of the radiation resistant amplifier. A radiation resistant wire insulation has also been utilized on those transmitters with the RRW designation added to the model series number.

The radiation and environmental testing performed by Foxboro and Westinghouse on the MCA/RRW versions of E11GM and GH and E13DM and DH Foxboro transmitters is interchangeable in its applicability to each of the models as well as other MCA/RRW versions of the E10 family of transmitters due to their design. The upper housing of the MCA type transmitters are identical (cast iron) and the O-ring sealing system of the upper housing is the same. The electronics of both the differential pressure and pressure sensing transmitters are identical. The sealing arrangement between the sensor housing and the electronic housing is the

BINDER NO. WBNEQ-ILT-001	PLANT WBN	UNIT(S) 1	SHEET 2 OF 2
BINDER TITLE FOXBORO XMTR	COMPUTED JCH	DATE 6/2/86	R ___ R ___
E13 SERIES	CHECKED AWC	DATE 6/4/86	

Discussion of Materials, Design, and Testing (Continued)

same in all of the E10 family of transmitters. There is a difference in electronic component functional values between the amplifiers producing 4-20 mA and 10-50 mA output signals. Radiation resistant versions of both the 4-20 mA and 10-50 mA amplifiers were subjected to the testing. The junction box for field wiring hookup and the Conax connector between the junction box and the transmitter housing are identical wherever used in the E10 family of transmitters.

INFORMATION ONLY

TVA 19537 (OE-3-86) EQP062.23

(3) Discussion of Qualified Life and Materials Susceptible to Thermal Aging - TAB B, Section H.

Accelerated thermal aging tests were not performed in the testing of the E10 family of transmitters. Accelerated aging tests were performed in the IEEE 323-1974 qualification testing of the N-E10 family of transmitters. Based on Foxboro's letter of 11-4-85 (See TAB E, item 9), the materials of construction |R2 for these E10, and the N-E10 transmitters are the same except for the amplifier. However, both the E10 and the N-E10 amplifiers have metal film resistors with an activation energy of 0.78 eV (refer to TAB E, item 3)* as the item most susceptible to age- |R2 related degradation. Therefore, the thermal aging of the N-E10 transmitters may be used as a basis for determining a qualified life for the E10 family of transmitters. The N-E10 transmitter |R2 aging was accomplished in two separate phases. Phase I subjected the transmitters to 2197 hours of thermal aging at 203°F. Phase II subjected these same test specimens to 387 hours of thermal aging at 203°F. Using the values listed above in Arrhenius calculations for a 120°F ambient temperature yields 8.45 + 1.49 |R2 years of life for a total qualified life of 10 years. Material aging calculation report WAC-120 is included to verify this determination.

INFORMATION ONLY

*The 0.78 eV value was verified by J. Gilbert Childer's telecon November 11, 1985, to Foxboro's Warren Myer.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 19

The NRC reviewer questioned if a wrong/incomplete report number is referenced.

The report numbers referenced in Section H (4)(b) of the subject EQ binders are correct. For WBN EQ Binder CABL-049 for Rockbestos signal cable (types MS and PXMJ), Report 1 and Report 2 as used in Tab B are the test reports listed on Page B-1 under items 1 and 2, respectively. For EQ Binder IPT-001 for Westinghouse pressure transmitters, the test report did not identify materials prone to degradation. Therefore, EPRI Report NP-155B was used to justify the use of an activation energy of 0.5 eV and is referenced in Tab B of the binder.

Note: Reference to K(6) seems to be inappropriate for this question.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Questions 20 and 21

The NRC reviewer questioned why the maximum flood level (submergence evaluation) was not applicable ("NA") for EQ binders ITS-001 and ITS-002 and questioned whether this item should be addressed as an open item.

The EQ Program generally provides for addressing submergence in response to questions contained in Tab B, Sections K (Required Operating Environment) and O (Summary of Review) of the binder. The maximum flood level resulting from a high energy line break (HELB) is specified on the Environmental Data Drawing for each room where potential flooding occurs.

Regarding the specific components addressed by this question, both binders have devices located in rooms which are not subject to flooding caused by a HELB. The question in Section K was marked "NA" and the question in Section O was marked "Yes" because the criteria concerning submergence was satisfied.

For further discussion of submergence, see Enclosure 1.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 22

The NRC reviewer questioned whether for certain components, why degradation which occurred during testing was not investigated and does failure invalidate the test.

As discussed below, the WBN EQ Program addresses such concerns and in fact, the relevant information is included in the EQ binder.

Regarding the specific components addressed by this question, the subject EQ Binder ITS-002 for Static-O-Ring temperature switches contains in Tab B, Section M and in the test report, a discussion of anomalies. Briefly, this discussion is based on test data set forth in Table 5 of the relevant test report No. 17344-82N-C. The discussion supports Acton's position that the anomalies are insignificant.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 23

The NRC reviewer questioned the remark "Nylon rollers are not acceptable and are controlled through TVA's maintenance program."

The EQ Program provides that Tab G of the EQ binder is to provide essential maintenance requirements.

Regarding the specific components addressed by this question, the Qualification Maintenance Data Sheets (QMDS) in Tab G of the subject EQ binders, which specify essential 10 CFR 50.49 related maintenance requirements, stipulate that nylon rollers are not acceptable for the limit switches delineated in the binders. The QMDS requires all operating levers and roller assemblies to be of metallic construction. The QMDS is utilized by plant maintenance personnel when performing maintenance on a device to insure the devices qualification is maintained.

Attached is an example excerpt from TAB G of EQ Binder IZS-005 for Namco EA180 limit switches (manufactured after 1986) noting this requirement.

QMDS

TAB G

A1 ESSENTIAL EQUIPMENT MAINTENANCE REQUIREMENTS (Continued)

II. ESSENTIAL EQUIPMENT INTERFACE REQUIREMENTS

1. A nuclear grade qualified conduit seal at the interfacing conduit connection to the housing must be provided to maintain the switch integrity under required service conditions (NAMCO controls or equivalent).

2. All switches which require seals are identified on page G-2 and G-3 of this TAB.

3. When service conditions require the switch conduit entrance to be sealed, the conduit threads must also have a qualified thread sealant applied. For thread sealant requirements when used with Namco connectors, refer to Binder No. WBNEQ-CSC-002. For thread sealant requirements when used with Conax connectors, refer to Binder WBNEQ-CSC-001. When conduit seals are not required, moisture intrustion is not a primary concern, and therefore, any commercial grade sealant may be used..

4. All operating lever and roller assemblies must be of metallic construction. Nylon rollers are not acceptable. NAMCO recommends the use of bronze arms and beryllim copper rollers for inside containment.

REFERENCE AND SOURCES OF INFORMATION: NAMCO Maintenance Instructions EA189-90055 (TAB H), NAMCO Installation Instructions EA189-90008 (TAB H), and NAMCO Qualification Report QTR 155 (TAB D).

INFORMATION ONLY

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 24

The NRC reviewer questioned a wrong comment number/comment not referenced.

NRC Inspector, Harold Walker, was contacted by telephone on October 14, 1992, to obtain additional clarification regarding the specific components addressed by this question (EQ binders CABL-052 and ILT-001); the section or page number was not identified, therefore, specific comments could not be made without additional clarification. Since the original reviewer was unavailable and specific details of the question were unknown, Mr. Walker agreed to omit this question.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 25

The NRC reviewer questioned the reason for checking more than one option under Section D - Qualification Methodology.

The EQ Program provides for designating one of the four methods of qualification.

Regarding EQ binders IZS-001, IZS-004, and IZS-005, these binders qualify a specific "series" of limit switches. The "series" is identified by unique model numbers. One unique model number was chosen for the actual qualification test and has been shown to be similar to the other model numbers from a qualification standpoint. Therefore, for the test specimen model, "testing of an identical item of equipment . . . " was appropriately checked in Section D. The other model numbers in the series are "qualified by a similar item of equipment with supporting analysis." An EQ binder which qualifies one specific model number will appropriately have checked one option in Tab B, Section D. However, it is acceptable for binders such as these to check more than one option to address more than one model number. A similarity discussion for the various model numbers can be found in Tab C of the binder. In summary, 10 CFR 50.49 (f) is satisfied because each item (i.e., model number) is qualified to only one of the four methods specified.

Regarding WBN EQ Binder ILT-001 (NUREG-0588, Category II), although the test reports cover Foxboro transmitter model E13DM, the same version was not used in all tests. Various features of the E13 series transmitters were addressed in the test reports listed in Tab B, Section A(1). Qualification of these E13DM transmitters is based on identical items for part of the tests and similarity to the various versions of the E13 series for the remaining tests.

Note, in concert with a design change the devices in this binder are being replaced. The binder, as a result, will be voided.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 26

The NRC reviewer asked why there were so many equipment location disclaimers for EQ Binder CABL-012 for Brand Rex signal cable (type MS).

Tab B, Section B, of the cable binders typically identifies areas in the plant where cables cannot be installed without further evaluation. Some areas have environmental parameters which are greater than that specified in qualification test reports, so that the vendor qualification test does not qualify cables to be installed in that area. The environmental parameters of the cable qualification test are the limiting factors which dictate where the cable may be installed. Tab B, Section B, is used to identify areas where cables in a specific binder cannot be qualified for use at WBN.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 27

The NRC reviewer asked that we clarify which industry standard is discussed in Tab B, Section I, of EQ Binder CABL-013 for TEFZEL signal cable.

In regard to EQ Binder CABL-013, the cables were tested using the guidelines of IEEE 323-1974 and IEEE 383-1974. Attached is an excerpt from the binder which documents this position.

BINDER NO. WBNEQ-CABL-013	PLANT WBN	UNIT(S) 1	SHEET 4 OF 34				
BINDER TITLE ENVIRONMENTAL QUALIFICATION DOCUMENTATION FOR CAROLINA SIGNAL CABLE	COMPUTED AMT	DATE 7-11-86	R	R			
	CHECKED WBK	DATE 7/17/86					

C. QUALIFICATION CRITERIA

Criteria Used to Demonstrate Qualification is in Accordance with the Following (Indicate Which Criteria is Applicable):

____ Components are Qualified to the Criteria of 10CFR50.49 and/or NUREG-0588 Category I (IEEE323-1974)

X Components are Qualified to the Criteria of NUREG-0588 Category II or the DOR Guidelines of IE Bulletin No. 79-01B (IEEE323-1971) (DOR Guidelines Applicable to only BFN)

JUSTIFICATION/COMMENTS

INDICATE OTHER REGULATORY DOCUMENTS AND/OR INDUSTRY STANDARDS MET

Test program for Report 1, Carolina's Report No. 46350-2, was in accordance with IEEE 323-1974 and IEEE 383-1974 guidelines.

INFORMATION ONLY

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PAGE B-4

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 28

The NRC reviewer questioned how years equivalence was determined for various hours of testing.

The EQ Program provides for the review of qualified life calculations through guidance given in the generic EQ Binder GEN-001.

Regarding the specific components addressed by this question, EQ binders HS-001, IZS-002, and IZS-004 address equivalency calculations by the Arrhenius methodology. Starting with demonstrated test results of time at a given temperature and an appropriately justified activation energy, qualified life calculations can be computed for various service temperatures. The service temperatures vary depending on the equipment's physical plant location. The calculated qualified lives are monitored through TVA's maintenance program as required by Tab G, "Qualification Maintenance Data Sheets (QMDS)."

Attached is an example of an EQ Binder Tab C discussion of various qualified lives for Ethylene Propylene Diene Monomer (EPDM) with respect to NUREG-0588 Category II zone switches (EQ binder IZS-004).

Materials Analysis (Continued) R1

3.5 EPDM

Using data obtained from ASCO Qualification Test Report 101083, Section 4.1 (attached) we use an activation energy of 0.94eV for EPDM in calculating its qualified life as follows with supporting test time and temperature from NAMCO QTR 111:

$$L_1 = L_2 \exp\left[\text{Ø}/K\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]$$

where:
L_2 = 408 hours
Ø = 0.94eV
K = 8.617×10^{-5} eV/°K
T_1 = 120°F = 322.04°K
T_2 = 120°C = 393.15°K

$$L_1 = 408 \exp\left[\frac{0.94}{8.617 \times 10^5}\left(\frac{1}{322.04} - \frac{1}{393.15}\right)\right] = 21.3 \text{ yrs at } 120°F$$

The abnormal conditions will occur less than 1 percent of the quaified life (21 years) (1839.6 hours). Substituting 1839.6 hours for L_1 and solving for T_1 yields:

$$T_1 = \left[\frac{8.617 \times 10^{-5} \text{ eV/°K} \ln\left(\frac{1839.6}{408}\right)}{0.94\text{eV}} + \frac{1}{393.15}\right]^{-1} = 372.91°K = 211.6°F$$

(for 1% of qualified life) R1

Which is more than the 130°F maximum abnormal temperature the environment will be at for 3504 hours (total time). Therefore, the EPDM parts are qualified for the normal and abnormal conditions they will be exposed to for 21.3 years.

INFORMATION ONLY

3.6 Lubricants

NAMCO Report QTR 111 (sheets attached and used in binder WBNEQ-IZS-003) concludes that the qualified life of the lubricant is controlled by the maintenance procedure and need not be established. This is based on the nature of oils and greases (designed for high temperature applications) and temperature rating of 475°F.

4.0 Conclusion:

The EPDM O-rings have a life of 21.3 years at 120°F based on a 0.94eV activation energy; for conservatism, the replacement interval will be calculated based on a 0.8 activation energy to yield a replacement interval of 8.6 years. The glass-filled polyester thermoset plastic part (contact block) has a life of greater than 40 years at 120°F and therefore will not require replacement during the plant's life.* The asbestos-filled phenolic thermoset plastic part (contact carrier) has a life of 21 years at 120°F based on a 0.827 activation energy. The silicone rubber top/bottom cover gaskets have a qualified life of greater than 40 years based on a 1.14eV activation energy at 120°F. However, for conservatism we will perform maintenance based on a 0.8eV activation energy to yield a 8.6 year replacement interval. Lubrication will also be performed at this 8.6 year interval for ease of schedule. The qualified lives and maintenance intervals of the switches located in maximum normal environments of 75°F and 110°F were calculated using this same reasoning, the results were as follows: life (and maintenance interval) at 75°F maximum normal temperature equaled 96.9 years (greater than plant life of 40 years); life (and maintenance interval) at a 110°F maximum normal temperature equaled 14.2 years. R2

*Note: See Page C-74 and C-74A for contact block and carrier material change. R1

INFORMATION ONLY

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 - Question 29

The NRC reviewer asked what methodology was employed for thermal aging and referenced Tab B, Section H(4) for EQ binders ILT-001 (Foxboro pressure transmitters) and ILP-001 (Hydrogen analyzers).

The WBN EQ Program generally uses the Arrhenius methodology in thermal aging except in isolated cases. Calculations performed by TVA use the Digital Equipment System 1000 computer program based upon the Arrhenius equation to generate qualified life and accident degradation calculations.

Regarding the specific components addressed by this question, some qualification test reports employ the "ten degree celsius" rule (example EQ Binder ILP-001 for Comsip Hydrogen Analyzers). In the case of this binder, an analysis was made to show that the aging employed was conservative as compared to the Arrhenius equation. Attached is an excerpt from a Comsip, Inc. letter which addresses this issue. This letter is contained in Tab E of EQ Binder ILP-001.

Refer to Enclosure 1 for further discussion of the thermal aging methodology.

For EQ Binder ILT-001, refer to TVA's responses in Enclosure 3 for questions 17 & 18.

B36 '89 1127 001

QA Record

COMSIP, INC.
instrument and control systems

September 25, 1989

INFORMATION ONLY

Ebasco Services, Inc.
Post Office Box 800
Spring City, Tennessee 37381

Attention: Mr. D. L. Kirby
Principal Nuclear Engineer
Watts Bar Engineering Project
Watts Bar Nuclear Plant

Reference: Containment Monitoring System
Original Purchase Order Number 77K5-821324
Comsip, Inc. Sales Order Number 80410

Gentlemen:

This is written in response to your letter dated September 08, 1989.

Enclosed please find the Comsip, Inc. Recommended Spare Parts Replacement Schedule. The only internal panel wiring that requires routine replacement is the 16 AWG wire in the hot box assembly (item number 35).

The Jefferson Transformer is not included in our generic system qualification documentation, but information obtained from the manufacturer indicates a design life of ten (10) years.

I have also enclosed a summary of the justification for using the 10°C Rule for a conservative aging program versus using the Arrhenius Equation.

If additional information or clarification is required, please do not hesitate to contact the undersigned.

Regards,

Beth Barbone

Beth Barbone
Western Service Manager

E3-68

BB/kp

PAGE E-161 R3

Enclosures

REPLY TO:

CUSTOMLINE DIVISION
1418 E. Linden Ave., P.O. Box 152
Linden, NJ 07036
(201) 486-1272 Telex 13-6396

DELPHI SYSTEMS DIVISION
3030 Red Hat Lane, P.O. Box 981
Whittier, CA 90601
(213) 692-[illegible]21 Telex: 67-4768
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DISTRIBUTED CONTROL SYSTEMS DIVISION
12603 Southwest Freeway, Suite 570
Stafford, Texas 77477
(713) 240-392[illegible] Telex: 77 4306

10°C VS. ARRHENIUS EQUATION

All components, whether an aging mechanism was known or not, are included in the thermal aging program for completeness. The 10°C Rule was used to determine aging temperatures and times. The components were separated into categories of ambient temperatures such that all aging times would be 100 days. All components were aged at temperatures below the manufacturers maximum storage temperature.

A comparison of the 10°C Rule vs. the Arrhenius Model is given in EPRI Report Number NP-1558. The 10°C Rule and the Arrhenius Model given the same aging times when the following equation is satisfied: $\frac{\phi}{T_1 T_2} = 5.97 \times 10^{-7}$ ev/K^2 in which ϕ is the activation energy in electron volts, T_1 and T_2 are the service and aging temperatures in degrees Kelvin. When $\frac{\phi}{T_1 T_2}$ is greater than 5.97×10^{-6}, the 10°C Rule will require an aging time longer than the Arrhenius Model and is therefore conservative. In all cases of known degradable materials used in the K Systems, the foregoing expression gives numbers greater than 5.97×10^{-6} and is therefore more conservative than if the Arrhenius Model had been used. (See Appendix 2)

INFORMATION ONLY

APPENDIX 2

The 10°C Rule and the Arrhenius equation are equivalent when $\frac{\phi}{T_1T_2} = 5.97 \times 10^{-6}$ where ϕ is the activation energy in eV and T_1 and T_2 are the service and aging temperatures in degrees K. If $\frac{\phi}{T_1T_2}$ is greater than 5.972×10^{-6}, then the 10°C Rule gives a conservative aging, i.e., the aging has been greater than required by the Arrhenius equation.

There are a number of organic materials used in the "K" Systems as well as semiconductors. Listed below are the materials, activation energies, etc. as well as the function $\frac{\phi}{T_1T_2}$:

MATERIAL	ϕ	SERVICE TEMPERATURE	AGING TEMPERATURE	$\frac{\phi}{T_1T_2}$
EPR	1.0	38°C	90°C	9.1×10^{-6}
Neoprene	0.87	38°C	80°C	7.9×10^{-6}
Silicon Rubber	1.5	149°C	191°C	7.6×10^{-6}
Op Amps	.9	38°C	80°C	8.2×10^{-6}

In all cases, $\frac{\phi}{T_1T_2}$ is greater than 5.972×10^{-6}. Therefore, the 10°C Rule gave a conservative aging program.

INFORMATION ONLY

REFERENCE: EPRI NP-1558, Project 890-1, "A Review of Equipment Aging Theory and Technology," Electric Power Research Institute.

WATTS BAR NUCLEAR PLANT (WBN)

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)
CONCERNING ENVIRONMENTAL QUALIFICATION (EQ)
SPECIAL PROGRAM

Response to RAI Enclosure 3 Question 30 (misnumbered as #21 in RAI)

The NRC reviewer questioned why there is a range of values for dose rate in EQ Binder ILT-001.

The dose rates used in the radiation test report No. T3-01097 in Tab D, page D-5, of EQ Binder ILT-001 were 1 X 10^5, 2 X 10^5, 1 X 10^6, and 2 X 10^6 rads/hr. One group of amplifiers were subjected to an initial dose rate of 1 X 10^5 rads/hr and increased during the test to 2 X 10^5 rads/hr for a total dose of 1 X 10^7 rads. The other group of amplifiers were subjected to an initial dose rate of 1 X 10^6 rads/hr and increased during the test to 2 X 10^6 rads/hr for a total dose of 2.2 X 10^8 rads. The test report does not state specifically the reason for varying the dose rate, but the manufacturer was probably trying to determine any sensitivity to dose rate. There were no discussions or indications of sensitivity to the dose rate in the test report. The varying of dose rate does not impact the qualification of the equipment.