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

References: Bruce A. Boger (NRC) letter to Tom Green (WOG), dated May 31, 1996, "Review of Westinghouse Electric Corporation Topical Reports WCAP-13878, Revision 1, WCAP-14117, Revision 1 and WCAP-13900, Revision 0, ESFAS Subgroup Test Interval Extension"

Thomas E. Essing (NRC) letter to Louis F. Liberatori (WOG), dated October 26, 1998, "Review of Westinghouse Owners Group Topical Reports WCAP 13877, Revision 1 WCAP-14129 Revision 1 and WCAP-13900 Revision 0, ESFAS Subgroup Relay Test Interval Extension"

SUBJECT: "Reliability Assessment of Potter & Brumfield MDR Series Relays", (WCAP-13878-P Rev 2) and "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays", (WCAP-13877 Rev 2-P)

The subject WCAPs are provided for your review and evaluation of corrections made in the documents as described below.

- the correct form of the Arrhenius equation is used to calculate the total service lives of relays energized 20% of the time and
- the aging reference temperature of Nylon Zytel 101 is changed from 160 °F to 175 °F and the activation energy (eV) is changed from 1.37 eV to 0.8787eV.

In general, the above corrections result in changes in calculated service lives of Nylon Zytel 101 and other materials as identified in the WCAPs. However, the corrections do not result in changes in any conclusion in the subject WCAPs.

For convenience of review, summaries of the changes for each of the subject WCAPs are attached. In addition, copies of the revised WCAPs are also attached. Changes in the WCAPs are indicated by revision bars on the left side of the page.

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ADD: Hukam Garg

The changes in the subject WCAPs do not change the conclusions, safety evaluation, Technical Specification mark-ups or scope of applicability in WCAP-13900 (Nonproprietary), "Extension of Slave Relay Surveillance Test Intervals", dated April 1994. The nonproprietary WCAPs (14117 and 14129) will be revised after NRC approval of the subject proprietary versions of the WCAPs.

Should you have any questions or require additional information, please telephone Mr. H. A. Sepp, Manager, Regulatory and Licensing Engineering at (412) 374-5282.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Attachments:

1. Summary of Changes Made in WCAP-13878-P Rev 2
2. Summary of Changes Made in WCAP-13877 Rev 2-P
3. WCAP-13878-P Rev 2, "Reliability Assessment of Potter & Brumfield MDR Series Relays", dated October 1999
4. WCAP-13877 Rev 2-P, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", dated October 1999

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ATTACHMENT 1

Summary of Changes Made in WCAP-13878-P, Rev 2

INTRODUCTION

WCAP-13878-P, Rev 2 (Reference 1) incorporates the following changes.

- the correct form of the Arrhenius equation is used to calculate the total service lives of relays energized 20% of the time (Section 8.2.2 and Appendix C),
- the aging reference temperature of Nylon Zytel 101 is changed from 160°C to 175°C (Table 8-1) and
- the activation energy (eV) of Nylon Zytel 101 is changed from 1.37 eV to 0.8787 eV (Table 8-1).

A discussion of the Arrhenius Equation change, aging reference temperature change and activation energy change for Nylon Zytel 101 and changes to WCAP-13878-P-A Rev 1 are provided below.

Arrhenius Equation

The aging assessment of Type MDR relays used as SSPS slave relays was performed using the Arrhenius equation documented in Section 8.2.2 and Appendix C of WCAP-13878-P-A Rev 1. However, this equation is not conservative for calculating the total service life for a defined duty cycle other than at 0% or 100%. The basis of the equation assumed that when a device is energized for a certain fraction of the calculated service life, the remaining fraction of the service life in an energized condition can then be expanded into a much larger time in a deenergized condition. These two times are not related to the duty cycle which is a fraction of the total service, e.g., a 50% duty cycle means that the relay is energized for 50% of its total service life and deenergized for 50% of its total service life. Using the corrected Arrhenius equation in Section 8.2.2 or Appendix C of WCAP-13878-P Rev 2 correctly calculates the total service life of the Type MDR relays at any defined duty cycle, such as, 0%, 20% and 100%.

Aging Reference Temperature for Nylon Zytel 101

Nylon Zytel 101 is the critical relay aging material for service life calculations. The aging reference temperature used in WCAP-13878-P-A Rev 1 to calculate service life for Nylon Zytel 101 is not correct. The aging reference temperature for 100 hours aging time should have been 175°C instead of the 160°C. WCAP-13878-P Rev 2 uses the correct aging reference temperature to calculate service lives of Nylon Zytel 101.

Activation energy (eV) of Nylon Zytel 101

The activation energy (eV) used in WCAP-13878-P-A Rev 1 to calculate service lives for Nylon Zytel 101 is not correct. The activation energy should have been 0.8787 eV instead of 1.37 eV. WCAP-13878-P Rev 2 uses the correct activation energy to calculate service lives of Nylon Zytel 101.

Impact on Service Lives

Using the corrected Arrhenius Equation, correct aging reference temperature for Nylon Zytel 101 and correct activation energy for Nylon Zytel 101 results in the following service life changes.

- Service lives of Nylon Zytel 101 are reduced for all duty cycles (i.e., normally deenergized, 20% energized and 100% energized) and

- Service lives of all other materials at 20% energization duty cycle are reduced.

WCAP-13878-P-A REV 1 CHANGES

The changes to the WCAP are mostly limited to the tables that provide calculated service lives of the relays energized 20% of the time. The only exceptions are the tables for Nylon Zytel 101 where the service lives of relays energized 100% of the time, 20% of the time and normally deenergized are all recalculated. As appropriate, the sections of the WCAP that discuss the tables are also changed.

The types of changes to the WCAP are:

- Service lives of material significantly reduced at 20% duty cycle but not essential for relay operation
- Recalculated service life values not less than 40 years at 20% duty cycle
- Service lives of Nylon Zytel 101 is significantly reduced
- Tables left blank intentionally

A summary of the types of changes and impacts to the WCAP are provided below. Typographical corrections, numeric changes and clarifications (in the text) in service lives associated with changes in the tables are included in the revised WCAPs but are not included in the summary below.

Service Lives of Material Significantly Reduced at 20 % Duty Cycle But Not Essential for Relay Operation

Description of Change

After recalculation, the service lives of the materials in the following tables have been significantly reduced at 20% duty cycle. The table, material and WCAP section number that discuss why the materials are not essential for relay operation are provided below. These reduced service life values do not change the conclusions in WCAP-13878-P-A Rev 1.

- Tables 8-4, 8-4a, 8-4b, 8-5, 8-5a and 8-5b (Neoprene Rubber) (Section 8.3.1, "... degradation of neoprene rubber material properties is of little concern. Even after complete disintegration of the grommets, failure of the MDR relay is neither expected nor likely.")
- Tables 8-8, 8-8a and 8-8b (Polyvinyl Chloride (PVC)) (Section 8.1.2.2, "This component was eliminated prior to applications of MDR relays in the Westinghouse SSPS, ...")

Impact on Referenced SER

The SER requirement is to confirm applicability of WCAP-13878 for each plant. In addition, calculated service lives are not tied to any requirement. Reevaluation of the extended surveillance interval is required if two or more P&B MDR relays fail in a 12-month period.

WCAP Section/Table Affected

Tables 8-4, 8-4a, 8-4b, 8-5, 8-5a, 8-5b, 8-8, 8-8a and 8-8b.

Recalculated Service Life Values Not Less Than 40 Years at 20% Duty Cycle

Description of Change

The service lives at 20% duty cycle were recalculated for Tables 8-6, 8-7, 8-9, 8-9a, 8-9b, 8-12, 8-13, 8-14, 8-14a, 8-14b, 8-15, 8-15a, 8-15b, 8-16, 8-16a, 8-18, 8-20, 8-20a, 8-21, 8-21a, 8-21b, 8-22 and 8-23. Since neither the 100% duty cycle nor the 0% duty cycle service lives of the relays are changed and the 20% duty cycle service lives are greater than 40 years, the conclusions in WCAP-13878-P-A Rev 1 are not changed as a result of these materials service life changes.

Impact on Referenced SER

The SER requirement is to confirm applicability of WCAP-13878 for each plant. In addition, calculated service lives are not tied to any requirement. Reevaluation of the

extended surveillance interval is required if two or more P&B MDR relays fail in a 12-month period.

WCAP Section/Table Affected

Tables 8-6, 8-7, 8-9, 8-9a, 8-9b, 8-12, 8-13, 8-14, 8-14a, 8-14b, 8-15, 8-15a, 8-15b, 8-16, 8-16a, 8-18, 8-20, 8-20a, 8-21a, 8-21b, 8-22 and 8-23.

Service Lives of Nylon Zytel 101 Is Significantly Reduced

Description of Change

The service lives of Nylon Zytel 101 at 100% duty cycle, 20% duty cycle and normally deenergized duty cycle are recalculated for Tables 8-10, 8-10a and 8-10b. All of the recalculated service lives are less than the originally calculated service lives. The MDR relay cam is made of Nylon Zytel 101. Section 8.3.5 of WCAP-13878-P-A Rev 1 notes that, "A total force applied to all four lobes of a cam would not exceed 400 grams." Based upon very low cam lobe loads, engineering judgment and the fact that no cam failures were reported in WCAP-13878-P-A Rev 1, the recalculated/reduced service lives do not change the conclusions in the WCAP.

Impact on Referenced SER

The SER requirement is to confirm applicability of WCAP-13878 for each plant. In addition, calculated service lives are not tied to any requirement. Reevaluation of the extended surveillance interval is required if two or more P&B MDR relays fail in a 12-month period.

WCAP Section/Table Affected

Tables 8-10, 8-10a and 8-10b.

Tables Left Blank Intentionally

Description of Change

Tables 8-11, 8-11a and 8-11b are left blank intentionally because the aging reference time and temperature and activation energy are not applicable for calculating the service lives of Nylon Zytel 101. The service lives of Nylon Zytel 101 are accurately reflected in Tables 8-10, 8-10a and 8-10b in WCAP-13878-P Rev 2. The conclusions to the WCAP are not changed.

Tables 8-17, 8-17a and 8-17b are left blank intentionally because the dielectric strength (50% retention) of Diallyl Phthalate is not a critical material parameter. The critical material parameter for Diallyl Phthalate is flexural strength (50% retention)

(Section 8.3.10 of WCAP-13878-P-A Rev 1). This parameter is accurately reflected in Tables 8-16 and 8-16a. The conclusions to the WCAP are not changed.

Table 8-19 is left blank intentionally because the dielectric strength of Glass-melamine is not a critical material parameter. Section 8.3.11 of WCAP-13878-P-A Rev 1 notes that even with substantial loss of dielectric strength, there is sufficient residual strength for MDR relay applications. Therefore, the conclusions to the WCAP are not changed.

Tables 8-24, 8-24a and 8-24b are left blank intentionally based upon response to RAI6.3 which states that, ".... the Tables 8-24 data are not directly applicable to SSPS MDR relay lifetimes. The data were based on more conservative activation energies than those applicable to the most limiting materials in the relay." In addition, Tables 8-24, 8-24a and 8-24b are not discussed in WCAP-13878-P-A Rev 1. Therefore, the conclusions in the WCAP are not changed.

Impact on Referenced SER

The SER requirement is to confirm applicability of WCAP-13878 for each plant. In addition, calculated service lives are not tied to any requirement. Reevaluation of the extended surveillance interval is required if two or more P&B MDR relays fail in a 12-month period.

WCAP Section/Table Affected

Tables 8-11, 8-11a, 8-11b, 8-17, 8-17a, 8-17b, 8-19, 8-24, 8-24a and 8-24b.

REFERENCE

1. WCAP-13878-P Rev 2, "Reliability Assessment of Potter & Brumfield MDR Series Relays", dated October 1999

ATTACHMENT 2

Summary of Changes Made in WCAP-13877 Rev 2-P

INTRODUCTION

WCAP-13877 Rev 2-P (Reference 1) incorporates the following changes.

- the correct form of the Arrhenius equation is used to calculate the total service life of relays energized 20% of the time (Appendix D) and
- the correct aging reference temperature is used to calculate the service live of Nylon Zytel 101 (Table 8-5).

A discussion of the Arrhenius Equation, aging reference temperature change for Nylon Zytel 101 and changes to WCAP-13877 Rev 1-P-A are provided below.

Arrhenius Equation

The aging assessment of Type AR relays used as SSPS slave relays was performed using the Arrhenius equation documented in Appendix D of WCAP-13877 Revision 1-P-A. However, this equation is not conservative for calculating the total service life for a defined duty cycle other than at 0% or 100% . The basis of the equation assumed that when a device is energized for a certain fraction of the calculated service life, the remaining fraction of the service life in an energized condition can then be expanded into a much larger time in a deenergized condition. These two times are not related to the duty cycle which is a fraction of the total service, e.g., a 50% duty cycle means that the relay is energized for 50% of its total service life and deenergized for 50% of its total service life. Using the corrected Arrhenius equation in Appendix D of WCAP-13877 Rev 2-P correctly calculates the total service life of the Type AR relays at any defined duty cycle, such as, 0%, 20% and 100%. Small numerical differences appear in some of the tables in WCAP-13877 Rev 2-P for 0% and 100% energization times due to differences in calculation software and rounding of numbers.

Aging Reference Temperature for Nylon Zytel 101

Nylon Zytel 101 is the critical relay aging material for service life calculations. The aging reference temperature used in WCAP-13877 Rev 1-P-A to calculate service life for Nylon Zytel 101 is not correct. The aging reference temperature for 100 hours aging time should have been 175°C instead of the 160°C. WCAP-13877 Rev 2-P uses the correct aging reference temperature to calculate service lives of Nylon Zytel 101. The recalculated service lives for Nylon Zytel 101 result in longer service lives.

WCAP-13877 Rev 1-P-A CHANGES

The changes to the WCAP are mostly limited to the tables that provide the calculated service life of the relays energized 20% of the time. As appropriate, the sections of the WCAP that discuss the tables are also changed. Where calculations were in the text only (not part of any table), changes were also made to be consistent with recalculated service lives.

The types of changes to the WCAP are:

- Changes in the calculated service lives of ARD Relay
- Recalculated service lives of AR Relay based on Nylon Zytel 101
- Recalculated service lives >> 40 years
- Small decreases in service lives

A summary of the types of changes and impacts to the WCAP are provided below. Typographical corrections and numeric changes (in the text) in service lives associated with changes in the tables are included in the revised WCAP but are not included in the below summary.

Changes in the Calculated Service Lives of ARD Relay

Description of Change

The service life values in Section 8.3.3 of the WCAP discuss the ARD relay failures at North Anna. The relay service lives are based upon estimated service conditions for the ARD relays at North Anna. The recalculated service lives are more conservative than the actual time that the ARD relay was in service. Therefore, the recalculated service lives of the ARD relay do not change the conclusions of WCAP-13877 Rev 1-P-A.

Impact on Referenced SER

The above service life values are not discussed in the SER. The SER requirement is to "determine the qualified life for the Type AR Relay based on plant-specific environmental conditions."

WCAP Section/Table Affected

Section 8.3.3, pages 8-8 and 8-9.

Recalculated Service Lives of AR Relay Based on Nylon Zytel 101

Description of Change

All of the service lives were recalculated in Tables 8-3 and 8-4. In both tables, all of the recalculated service life values that were originally >> 40 years continue to be >> 40 years. For the remaining service life values, the recalculated values are greater than the originally calculated values. This change is discussed in Section 8.3.4. The original recommendation of 19-year service life replacement for normally energized relays is not changed nor is the recommendation that if any relay should fail after 14 years, all the relays should be replaced.

Impact on Referenced SER

The above service life value changes are still in the conservative direction. The SER requirement is to "establish a program to evaluate the adequacy of the proposed test interval if two or more AR relays fail in a 12-month period."

WCAP Section/Table Affected

Section 8.3.4, Tables 8-3 and 8-4

Recalculated Service Lives >> 40 Years

Description of Change

All of the service lives were recalculated in Tables 8-6 through 8-15. In all of the tables, all of the original services lives that were >> 40 years continue to be >> 40 years after being recalculated. Service live value changes are made in various sections of the WCAP to be consistent with the tables, however, no conclusions are changed.

Impact on Referenced SER

The service life value of >> 40 years is not changed. The SER requirement is to "determine the qualified life for the Type AR Relay based on plant-specific environmental conditions."

WCAP Section/Table Affected

Tables 8-6 through 8-15

Small Decreases in Service Lives

Description of Change

All of the service lives were recalculated in Tables 8-16 and 8-17. Small decreases (5.1% maximum) in the service lives occur when the relay is energized 20% of the time with a 5°C temperature rise. Except for a few minor computational software differences, neither the 100% normally energized nor the normally de-energized service lives are affected. Section 8.9 discusses Tables 8-16 and 8-17. Neither the discussions in Section 8.9 nor the conclusion is changed as a result of these minor service life changes.

Impact on Referenced SER

The service lives in Tables 8-16 and 8-17 are not discussed in the SER. The SER requirement is to "determine the qualified life for the Type AR Relay based on plant-specific environmental conditions."

WCAP Section/Table Affected

Tables 8-16 and 8-17

REFERENCE

1. WCAP-13877 Rev 2-P, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", dated October 1999